AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.3.4

Factors affecting braking distance 2

Past-paper questions

Tier	**Higher**
Question groups	**14**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

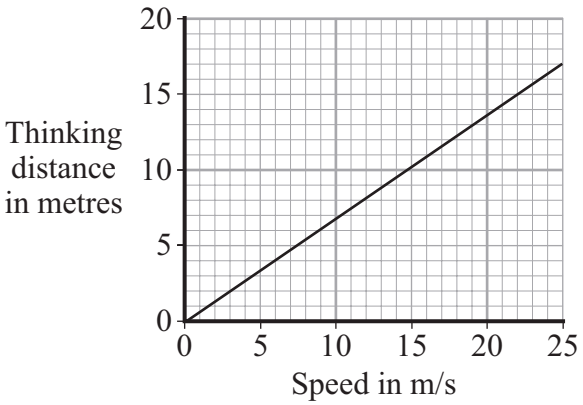
4.5.6.3.4 Factors affecting braking distance 2

Question 01

June 2008 | PHY2H | Original Q3 | Legacy

3 (a) A car driver takes a short time to react to an emergency before applying the brakes. The distance the car will travel during this time is called the 'thinking distance'.

The graph shows how the thinking distance of a driver depends on the speed of the car.



3 (a) (i) What is the connection between thinking distance and speed?

.....

(1 mark)

3 (a) (ii) Many people drive while they are tired.

Draw a new line on the graph to show how thinking distance changes with speed for a tired driver.

(1 mark)

3 (a) (iii) The graph was drawn using data given in the Highway Code.

Do you think that the data given in the Highway Code is likely to be reliable?

Draw a ring around your answer.

Yes **No** **Maybe**

Give a reason for your answer.

.....

.....

(1 mark)

Question 3 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 01 · continued

for mark

3 (b) The distance a car travels once the brakes are applied is called the 'braking distance'.

3 (b) (i) What is the relationship between thinking distance, braking distance and stopping distance?

.....

(1 mark)

3 (b) (ii) State **two** factors that could increase the braking distance of a car at a speed of 15 m/s.

1 .....

2 .....

(2 marks)

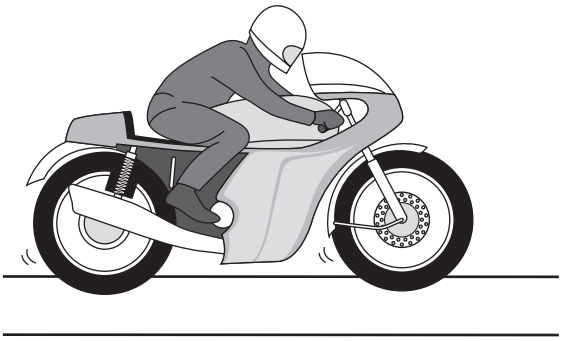
6

4.5.6.3.4 Factors affecting braking distance 2

Question 02

June 2009 | PHY2H | Original Q5 | Legacy

5 The diagram shows a motorbike of mass 300 kg being ridden along a straight road.



The rider sees a traffic queue ahead. He applies the brakes and reduces the speed of the motorbike from 18 m/s to 3 m/s.

5 (a) Use the equation in the box to calculate the kinetic energy lost by the motorbike.

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$$

Show clearly how you work out your answer.

.....

.....

.....

.....

Kinetic energy lost = ... J

(2 marks)

5 (b) (i) How much work is done on the motorbike by the braking force?

.....

(1 mark)

5 (b) (ii) What happens to the kinetic energy lost by the motorbike?

.....

(1 mark)

4

4.5.6.3.4 Factors affecting braking distance 2

Question 03

1 A car has an oil leak. Every 5 seconds an oil drop falls from the bottom of the car onto the road.

1 (a) What force causes the oil drop to fall towards the road?

.....

(1 mark)

1 (b) The diagram shows the spacing of the oil drops left on the road during part of a journey from A to B.



Describe the motion of the car as it moves from **A** to **B**.

.....

Explain the reason for your answer.

.....

.....

.....

.....

(3 marks)

1 (c) When the brakes are applied, a braking force slows down and stops the car.

1 (c) (i) The size of the braking force affects the braking distance of the car.

State **one** other factor that affects the braking distance of the car.

.....

(1 mark)

4.5.6.3.4 Factors affecting braking distance 2

Question 03 · continued

1 (c) (ii) A braking force of 3 kN is used to slow down and stop the car in a distance of 25 m.

Calculate the work done by the brakes to stop the car and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Work done =.....

(3 marks)

8

Turn over for the next question

4.5.6.3.4 Factors affecting braking distance 2

Question 04

June 2013 | PH2HP | Original Q4 | Legacy

4 (a) The stopping distance of a vehicle is made up of two parts, the thinking distance and the braking distance.

4 (a) (i) What is meant by *thinking distance*?

.....

.....

(1 mark)

4 (a) (ii) State **two** factors that affect thinking distance.

1 .....

.....

2 .....

.....

(2 marks)

4 (b) A car is travelling at a speed of 20 m/s when the driver applies the brakes. The car decelerates at a constant rate and stops.

4 (b) (i) The mass of the car and driver is 1600 kg.

Calculate the kinetic energy of the car and driver before the brakes are applied.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Kinetic energy = ... J

(2 marks)

4 (b) (ii) How much work is done by the braking force to stop the car and driver?

Work done = ... J

(1 mark)

4.5.6.3.4 Factors affecting braking distance 2

Question 04 · continued June 2013 | PH2HP | Original Q4 | Legacy

4 (b) (iii) The braking force used to stop the car and driver was 8000 N.

Calculate the braking distance of the car.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Braking distance = ... m

(2 marks)

4 (b) (iv) The braking distance of a car depends on the speed of the car and the braking force applied.

State **one** other factor that affects braking distance.

.....

.....

(1 mark)

4 (b) (v) Applying the brakes of the car causes the temperature of the brakes to increase.

Explain why.

.....

.....

.....

.....

(2 marks)

Question 4 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 04 · continued

4 (c) Hybrid cars have an electric engine and a petrol engine. This type of car is often fitted with a regenerative braking system. A regenerative braking system not only slows a car down but at the same time causes a generator to charge the car's battery.

State and explain the benefit of a hybrid car being fitted with a regenerative braking system.

.....

.....

.....

.....

.....

.....

(3 marks)

14

4.5.6.3.4 Factors affecting braking distance 2

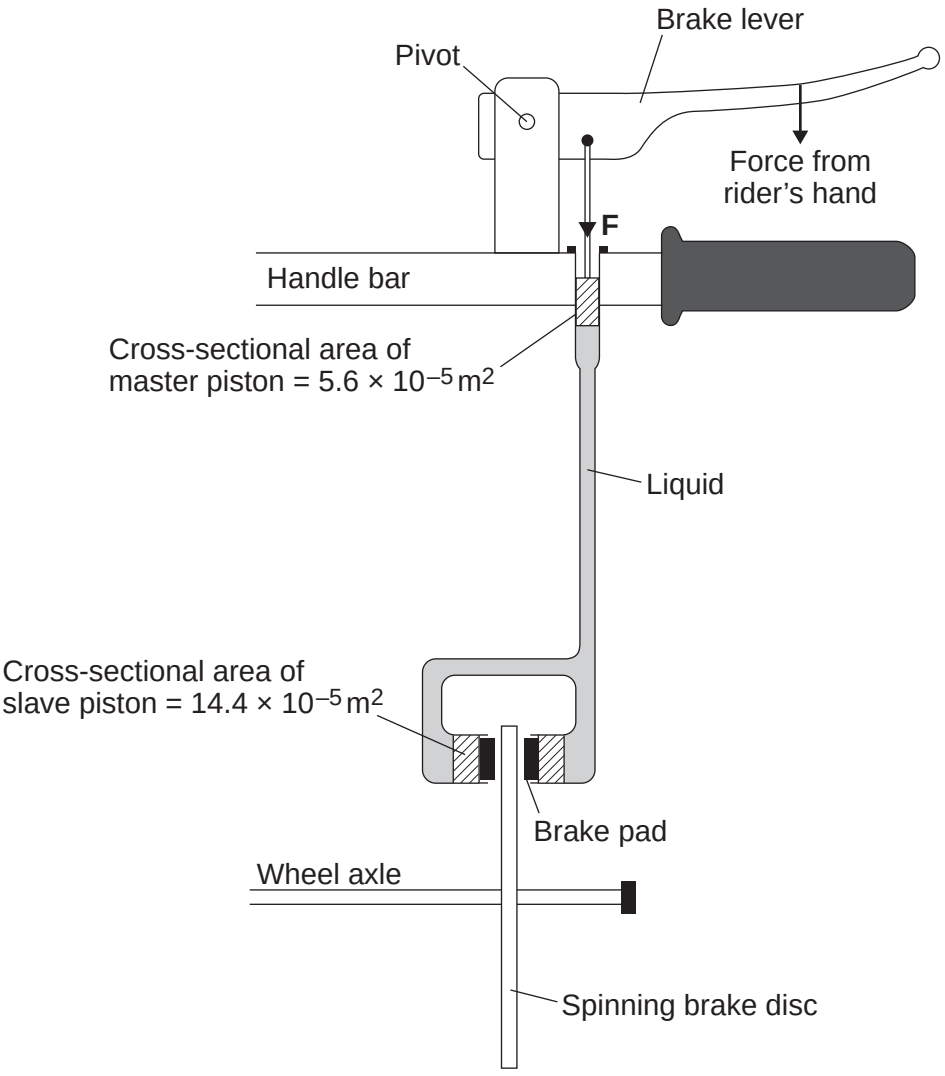
Question 05

June 2013 | PH3HP | Original Q4 | Legacy

4 Mountain bike riders use brakes to slow down.



Some mountain bikes have hydraulic brakes.



4.5.6.3.4 Factors affecting braking distance 2

Question 05 · continued

4 (a) What property of a liquid enables a hydraulic brake system to work?

.....

(1 mark)

4 (b) When the rider's hand pulls on the brake lever, the master piston applies a pressure of 1.5×10^6 pascals to the liquid.

Using information from the diagram, calculate the force **F** exerted on the liquid by the master piston.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Force **F** = ... N

(2 marks)

4 (c) The pressure in the liquid applies a force to move each slave piston.

How does the size of this force compare to the force **F** applied by the master piston?

.....

.....

Give a reason for your answer.

.....

.....

(2 marks)

5

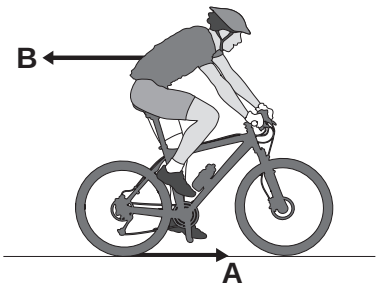
4.5.6.3.4 Factors affecting braking distance 2

Question 06

June 2014 | PH2HP | Original Q3 | Legacy

3 (a) **Figure 2** shows the horizontal forces acting on a moving bicycle and cyclist.

Figure 2



3 (a) (i) What causes force **A**?

Draw a ring around the correct answer.

[1 mark]

friction **gravity** **weight**

3 (a) (ii) What causes force **B**?

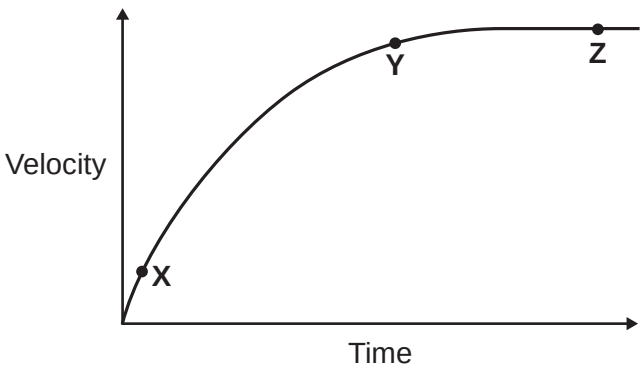
[1 mark]

.....

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

Figure 3 shows how the velocity of the cyclist changes during the first part of a journey along a straight and level road. During this part of the journey the force applied by the cyclist to the bicycle pedals is constant.

Figure 3



4.5.6.3.4 Factors affecting braking distance 2

Question 06 · continued

Describe how **and** explain, in terms of the forces **A** and **B**, why the velocity of the cyclist changes:

- between the points **X** and **Y**
- and between the points **Y** and **Z**, marked on the graph in **Figure 3**.

[6 marks]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Extra space .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4.5.6.3.4 Factors affecting braking distance 2

Question 06 · continued

3 (b) (i) The cyclist used the brakes to slow down and stop the bicycle.

A constant braking force of 140 N stopped the bicycle in a distance of 24 m.

Calculate the work done by the braking force to stop the bicycle. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

Work done = ...

3 (b) (ii) Complete the following sentences.

[2 marks]

When the brakes are used, the bicycle slows down. The kinetic energy of the bicycle ..... .

At the same time, the ..... of the brakes increases.

13

4.5.6.3.4 Factors affecting braking distance 2

Question 07

June 2015 | PH2HP | Original Q4 | Legacy

4 (a) A car driver sees the traffic in front is not moving and brakes to stop his car.

The stopping distance of a car is the thinking distance plus the braking distance.

4 (a) (i) What is meant by the 'braking distance'?

[1 mark]

.....

.....

4 (a) (ii) The braking distance of a car depends on the speed of the car and the braking force.

State **one** other factor that affects braking distance.

[1 mark]

.....

.....

4 (a) (iii) How does the braking force needed to stop a car in a particular distance depend on the speed of the car?

[1 mark]

.....

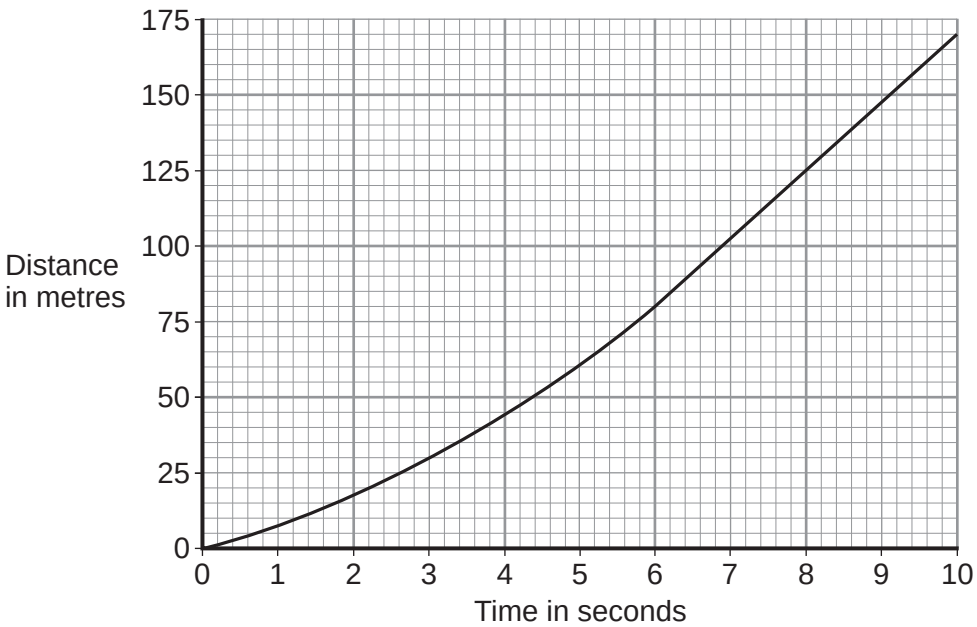
.....

Question 4 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

4 (b) **Figure 4** shows the distance–time graph for the car in the 10 seconds before the driver applied the brakes.

Figure 4



Use **Figure 4** to calculate the maximum speed the car was travelling at.
Show clearly how you work out your answer.

[2 marks]

.....

.....

Maximum speed = ... m/s

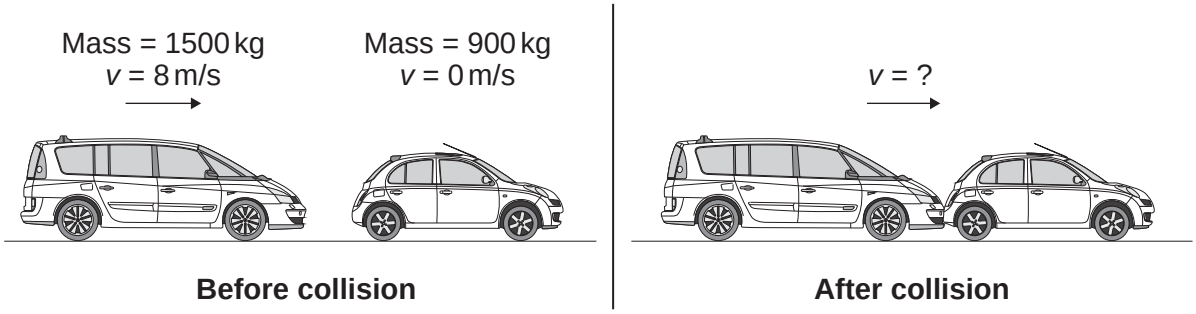
4.5.6.3.4 Factors affecting braking distance 2

Question 07 · continued

4 (c) The car did not stop in time. It collided with the stationary car in front, joining the two cars together.

Figure 5 shows both cars, just before and just after the collision.

Figure 5



Before collision **After collision**

4 (c) (i) The momentum of the two cars was conserved.

What is meant by the statement 'momentum is conserved'?

[1 mark]

.....

.....

4 (c) (ii) Calculate the velocity of the two joined cars immediately after the collision.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

.....

Velocity = ... m/s

Question 4 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 07 · continued

4 (d) Since 1965, all cars manufactured for use in the UK must have seat belts.

It is safer for a car driver to be wearing a seat belt, compared with not wearing a seat belt, if the car is involved in a collision.

Explain why.

[4 marks]

.....

.....

.....

.....

.....

.....

.....

.....

13

4.5.6.3.4 Factors affecting braking distance 2

Question 08

June 2017 | PH2HP | Original Q4 | Legacy

4 A lorry driver sees the traffic lights at a road junction change to red.
The driver applies the brakes to stop the lorry.

The stopping distance is the thinking distance plus the braking distance.

4 (a) (i) Which statement describes the thinking distance?

[1 mark]

Tick (✓) **one** box.

- The time it takes for the lorry to stop after the brakes are applied. ☐
- The time it takes the driver to react and apply the brakes. ☐
- The distance the lorry travels once the brakes are applied. ☐
- The distance the lorry travels during the driver's reaction time. ☐

4 (a) (ii) How does thinking distance depend on the speed of the lorry?

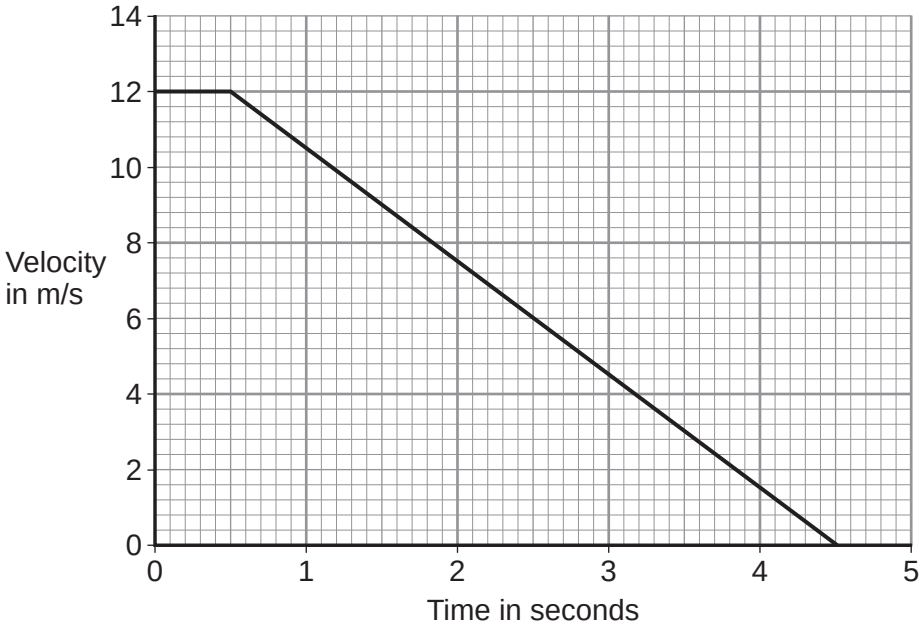
[1 mark]

_____

_____

4 (b) **Figure 3** shows how the velocity of the lorry changes from just after the driver sees the traffic lights change to red.

Figure 3



4.5.6.3.4 Factors affecting braking distance 2

Question 08 · continued

4 (b) (i) Calculate the braking distance of the lorry.

Show how you used **Figure 3** to obtain your answer.

[2 marks]

Distance = _____ m

4 (b) (ii) The work done to stop the lorry is 360 kJ

Calculate the braking force used to stop the lorry.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Braking force = _____ N

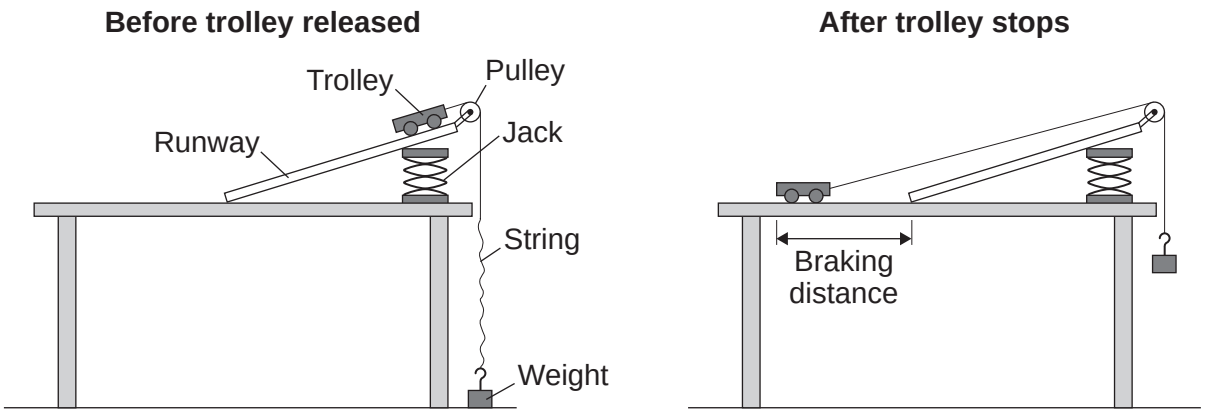
Question 4 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 08 · continued

4 (c) A student investigated how braking distance depends on braking force. The student used the apparatus shown in **Figure 4**.

Figure 4



The student released the trolley from the top of the runway. When the trolley reached the bottom of the runway the string became taut and the trolley started to lift a weight from the floor. The weight being lifted was equal to the braking force on the trolley.

The student changed the weight being lifted and measured the new braking distance.

4 (c) (i) State **one** control variable in this investigation.

[1 mark]

4 (c) (ii) **Figure 4** shows the braking distance measured by the student.

What else could the student have measured that would also have given the braking distance?

[1 mark]

4.5.6.3.4 Factors affecting braking distance 2

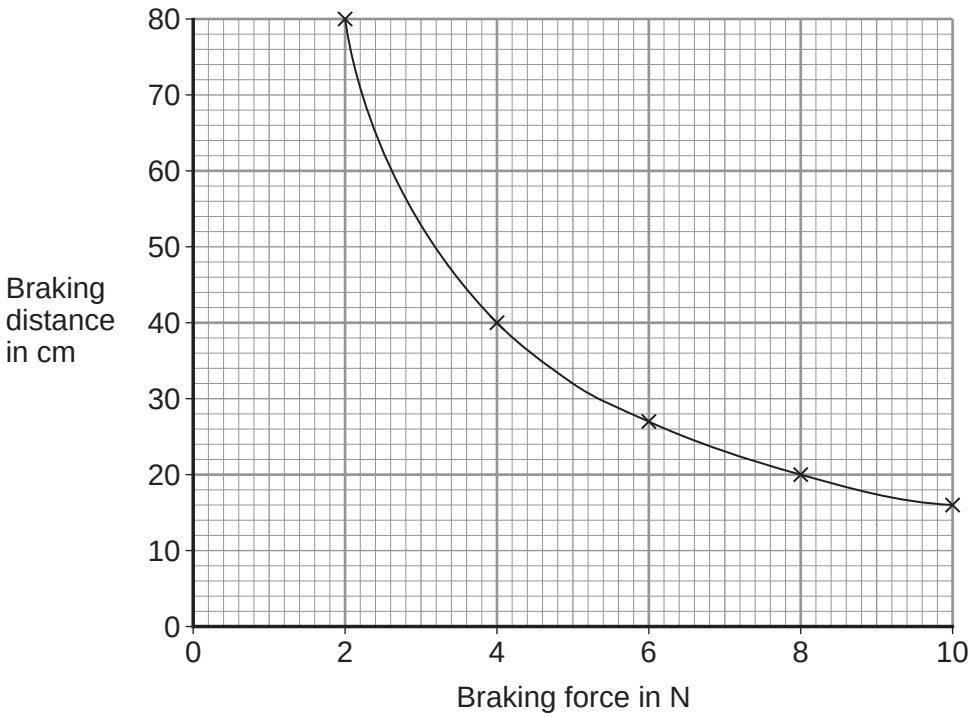
Question 08 · continued

4 (c) (iii) Measuring each braking distance at least twice would improve the investigation. Suggest why.

[2 marks]

4 (c) (iv) The results of the investigation are plotted as a graph in **Figure 5**.

Figure 5



What conclusions should be made from this investigation about the relationship between braking distance and braking force?

Use data from **Figure 5** to justify your conclusion.

[2 marks]

12

4.5.6.3.4 Factors affecting braking distance 2

Question 09

June 2019 | 8463/2H | Original Q3

0 3 . 1 The driver of a vehicle sees a hazard on the road.

The driver uses the brakes to stop the vehicle.

Explain the factors that affect the distance needed to stop a vehicle in an emergency.

[6 marks]

4.5.6.3.4 Factors affecting braking distance 2

Question 09 · continued

0 3 . 2 Write down the equation which links distance, force and work done.

[1 mark]

0 3 . 3 The work done by the braking force to stop a vehicle was 900 000 J

The braking force was 60 000 N

Calculate the braking distance of the vehicle.

[3 marks]

Braking distance = _____ m

0 3 . 4 The greater the braking force, the greater the deceleration of a vehicle.

Explain the possible dangers caused by a vehicle having a large deceleration when it is braking.

[2 marks]

12

4.5.6.3.4 Factors affecting braking distance 2

Question 10

November 2021 | 8463/2H | Original Q1

0 1 The thinking distance and braking distance for a car vary with the speed of the car.

0 1 . 1 Explain the effect of **two** other factors on the **braking** distance of a car.

Do **not** refer to speed in your answer.

[4 marks]

Question 1 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 10 · continued

0 1 . 2 Which equation links acceleration (a), mass (m) and resultant force (F).

[1 mark]

Tick (✓) **one** box.

resultant force = mass × acceleration ☐

resultant force = mass × acceleration^2 ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}^2}$ ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}}$ ☐

0 1 . 3 The mean braking force on a car is 7200 N.

The car has a mass of 1600 kg.

Calculate the deceleration of the car.

[3 marks]

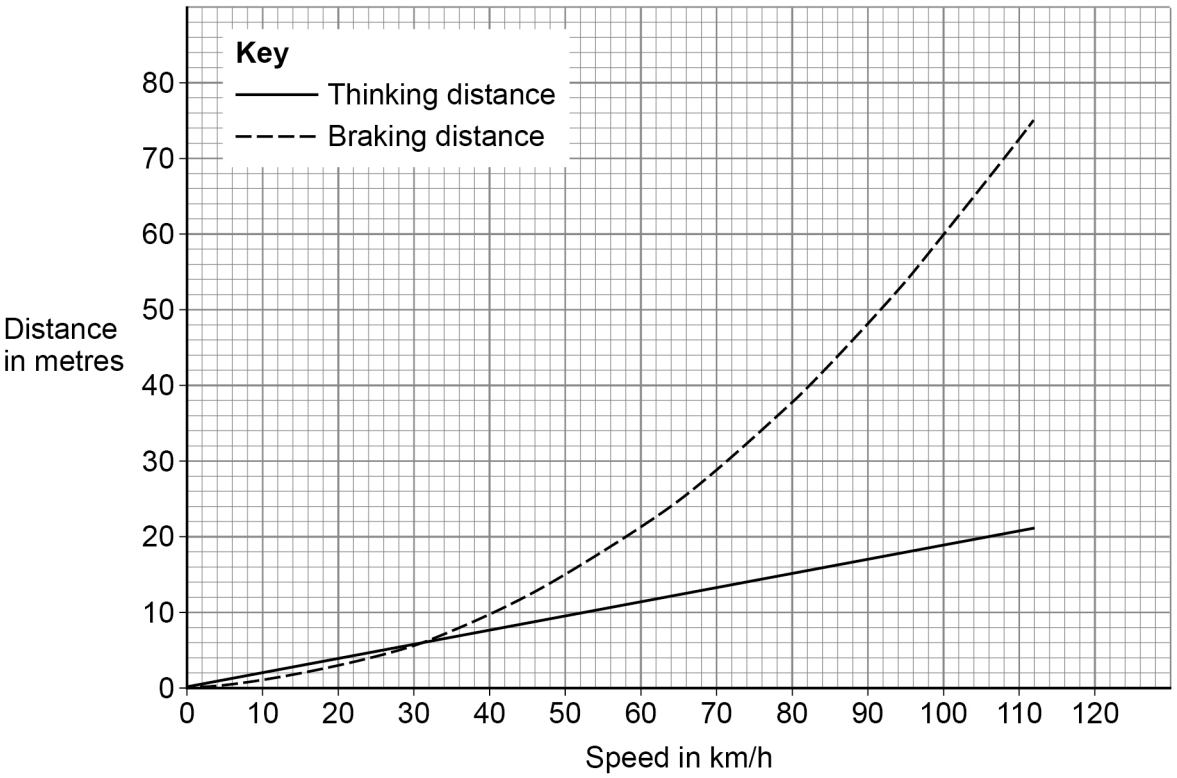
Deceleration = _____ m/s^2

4.5.6.3.4 Factors affecting braking distance 2

Question 10 · continued

0 1 . 4 **Figure 1** shows how the thinking distance and braking distance for a car vary with the speed of the car.

Figure 1



Determine the stopping distance when the car is travelling at 80 km/h.

[2 marks]

Stopping distance = _____ m

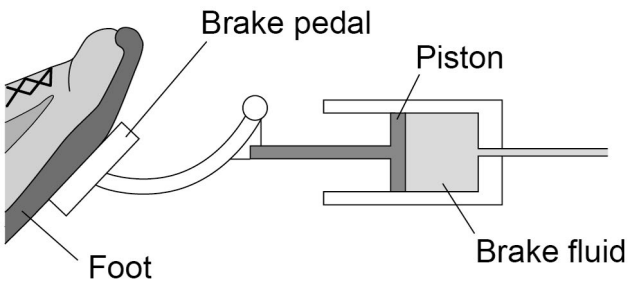
Question 1 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 10 · continued

Figure 2 shows part of the braking system for a car.

Figure 2



0 1 . 5 Which equation links area of a surface (A), the force normal to that surface (F) and pressure (p).

[1 mark]

Tick (✓) **one** box.

$p = F \times A$ ☐

$p = F \times A^2$ ☐

$p = \frac{F}{A}$ ☐

$p = \frac{A}{F}$ ☐

4.5.6.3.4 Factors affecting braking distance 2

Question 10 · continued

0 1 . 6 When the brake pedal is pressed, a force of 60 N is applied to the piston.

The pressure in the brake fluid is 120 000 Pa.

Calculate the surface area of the piston.

Give your answer in standard form.

Give the unit.

[5 marks]

Surface area (in standard form) = _____ Unit _____

16

4.5.6.3.4 Factors affecting braking distance 2

Question 11

June 2022 | 8463/2HR | Original Q3

0 3 Speed limits on roads increase safety.

0 3 . 1 The braking distance of a car increases as the speed of the car increases.

Give two **other** factors that **increase** the braking distance of a car.

[2 marks]

1 _____

2 _____

0 3 . 2 Explain why the driver's reaction time affects the thinking distance of a car.

[2 marks]

_____

_____

_____

_____

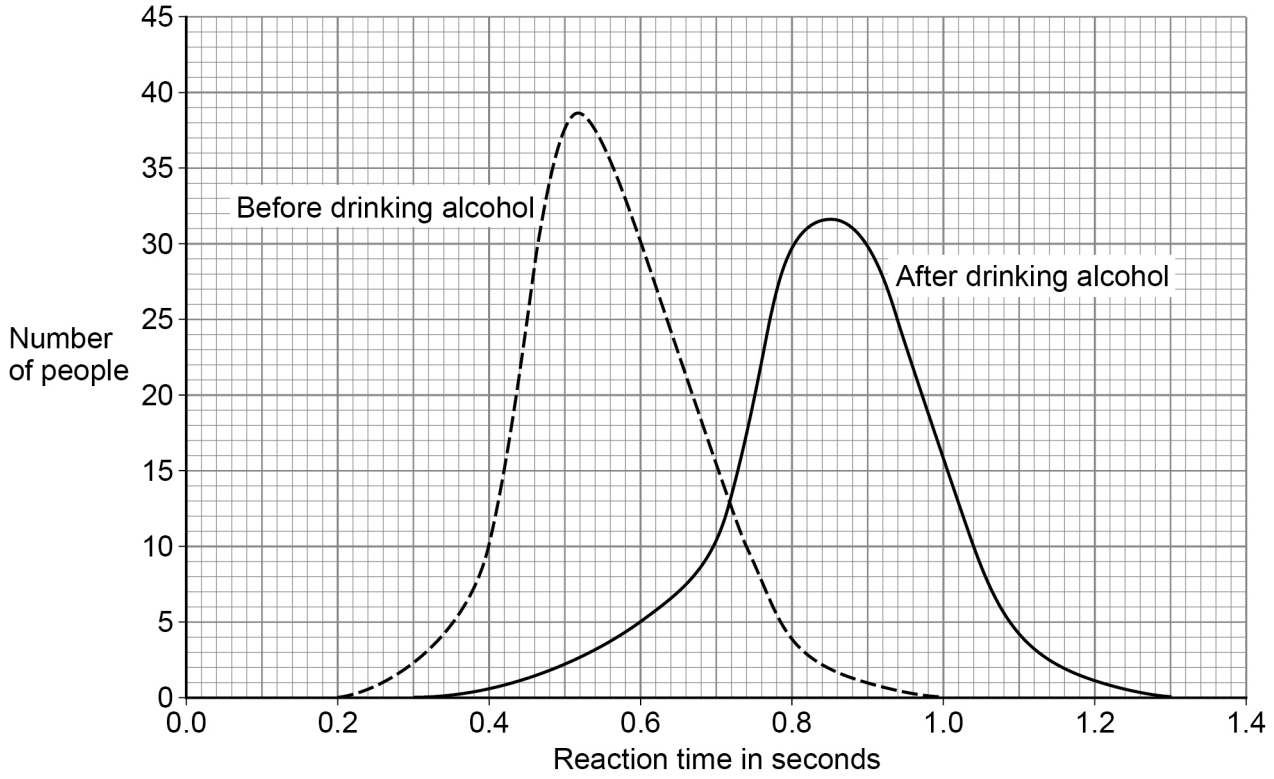
4.5.6.3.4 Factors affecting braking distance 2

Question 11 · continued

0 3 . 3 Scientists have investigated how drinking alcohol affects a person's reaction time.

Figure 5 shows the results of the investigation.

Figure 5



Which of the following conclusions can be made using **Figure 5**?

[2 marks]

Tick (✓) **two** boxes.

- Every person's reaction time increases after drinking alcohol. ☐
- Mean reaction time increases after drinking alcohol. ☐
- Some people's reaction time is not affected by drinking alcohol. ☐
- The change in reaction time is not the same for all people after drinking alcohol. ☐
- There is a smaller range of reaction times after drinking alcohol. ☐

Question 3 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

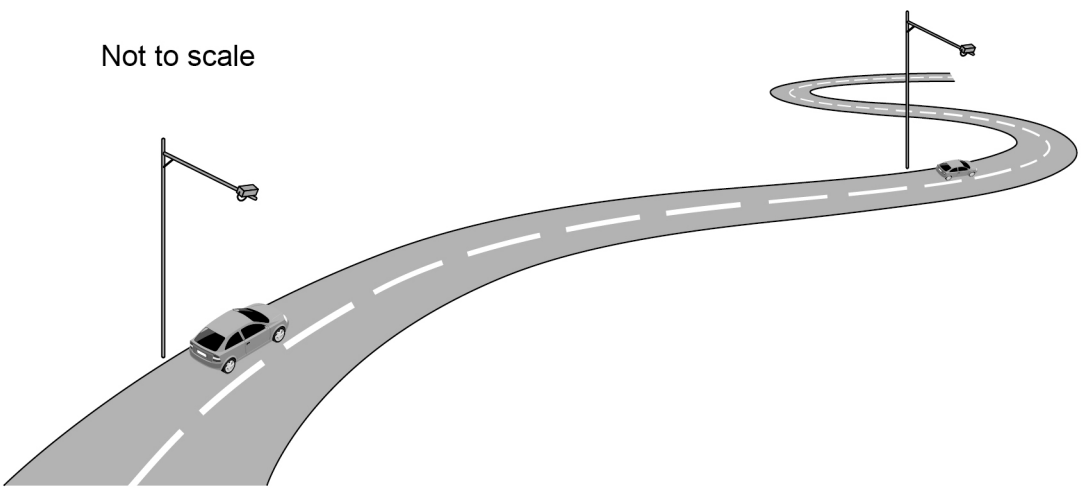
Question 11 · continued

Figure 6 shows some speed cameras on a road.

The speed cameras determine the average speed of cars on the road.

Figure 6

Not to scale



0 3 . 4 The speed limit on the road in **Figure 6** is 20 m/s.

The cameras in **Figure 6** are 1.5 km apart.

Calculate the minimum time it takes to travel 1.5 km without breaking the speed limit.

Use the Physics Equations Sheet.

[4 marks]

Minimum time = _____ s

4.5.6.3.4 Factors affecting braking distance 2

Question 11 · continued

0 3 . 5 The average speed of a car between the cameras and the average velocity of the car between the cameras are different.

Explain why.

[3 marks]

13

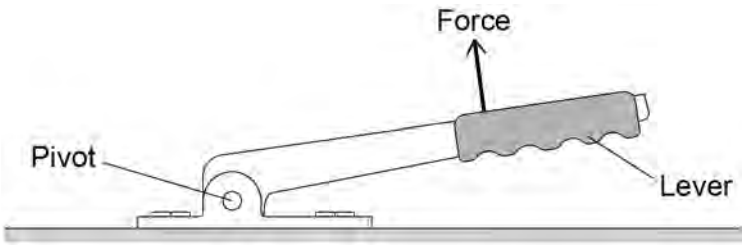
4.5.6.3.4 Factors affecting braking distance 2

Question 12

0 3 Some cars have a lever that is used to apply the handbrake.

Figure 8 shows the handbrake lever in a car.

Figure 8



0 3 . 1 The driver applies the force shown in **Figure 8**. The force produces a moment about the pivot.

How could the driver increase the moment about the pivot without increasing the size of the force?

[1 mark]

Question 3 continues on the next page

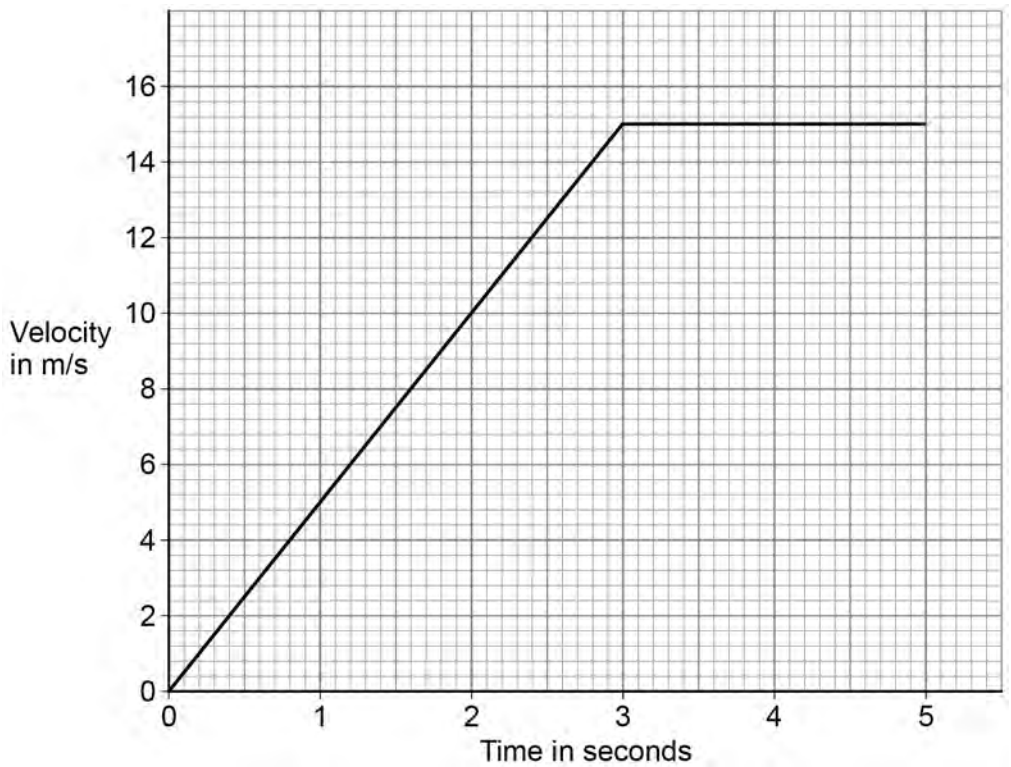
4.5.6.3.4 Factors affecting braking distance 2

Question 12 · continued

The driver releases the handbrake.

Figure 9 shows how the velocity of the car changes during the first 5 seconds of a journey.

Figure 9



0 3 . 2 After 3 seconds, the momentum of the car is 24 000 kg m/s.

Calculate the mass of the car.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

4.5.6.3.4 Factors affecting braking distance 2

Question 12 · continued

0 3 . 3 Determine the distance travelled by the car during the first 5 seconds of the journey.

Use **Figure 9**.

[3 marks]

Distance travelled by the car = _____ m

Question 3 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 12 · continued

0 3 . 4 In an emergency the driver needs to apply the brakes suddenly to stop the car quickly.

The driver of the car is distracted.

Explain why the distraction will increase the stopping distance.

[3 marks]

0 3 . 5 Explain why the temperature of the brakes increases as they are used.

[2 marks]

13

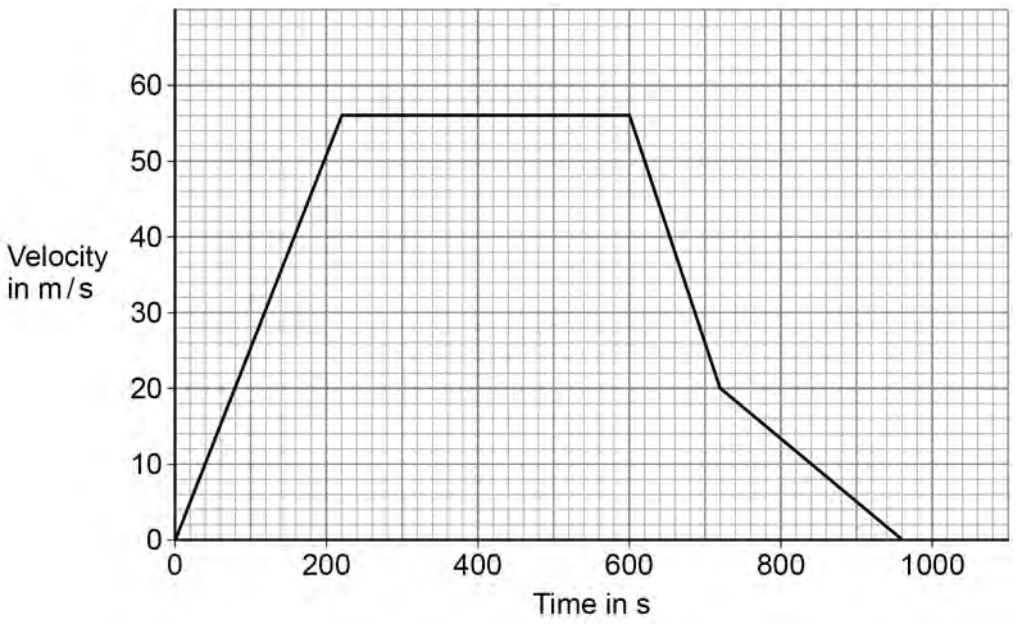
4.5.6.3.4 Factors affecting braking distance 2

Question 13

June 2024 | 8463/2H | Original Q7

0 7 **Figure 12** shows a velocity–time graph for a train travelling between two stations.

Figure 12



0 7 . 1 Determine the distance travelled by the train in the first 600 s of the journey.

[3 marks]

Distance = _____ m

4.5.6.3.4 Factors affecting braking distance 2

Question 13 · continued

0 7 . 2 Explain what happens to the braking force as the train decelerates.

Use information from **Figure 12**.

[3 marks]

0 7 . 3 Determine the maximum deceleration of the train.

[3 marks]

Deceleration = _____ m/s^2

Question 7 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 13 · continued

0 7 . 4 Another train travels at a speed of 60 m/s.

A constant braking force of 270 000 N causes the train to decelerate and stop.

mass of train = 240 000 kg

Calculate the distance travelled while the braking force is applied.

Use the Physics Equations Sheet.

[6 marks]

Distance travelled = _____ m

4.5.6.3.4 Factors affecting braking distance 2

Question 13 · continued

0 7 . 5 It is illegal for train drivers to drink alcohol before driving a train.

Explain how drinking alcohol would affect the stopping distance of a train.

[3 marks]

18

Turn over for the next question

4.5.6.3.4 Factors affecting braking distance 2

Question 14

June 2025 | 8463/2H | Original Q6

0 6 A car manufacturer makes two cars, **X** and **Y**.

The cars are identical, apart from their mass.

Car **X** has a greater mass than car **Y**.

0 6 . 1 How does the maximum acceleration of car **X** compare with the maximum acceleration of car **Y**?

[1 mark]

0 6 . 2 Cars have air bags that inflate to protect the driver if the car stops very suddenly.

Explain how air bags reduce the chance of injury to the driver.

[3 marks]

Question 6 continues on the next page

4.5.6.3.4 Factors affecting braking distance 2

Question 14 · continued

0 6 . 3 Car **X** has a mass of 1400 kg and is travelling at 18 m/s.

The driver applies the brakes.

The car has a constant deceleration and comes to a stop in a distance of 24 m.

Calculate the resultant force on the car.

Use the Physics Equations Sheet.

[5 marks]

Resultant force = _____ N

0 6 . 4 Explain why braking causes an increase in the temperature of the brakes.

[2 marks]

4.5.6.3.4 Factors affecting braking distance 2

Question 14 · continued

0 6 . 5 The driver of a car applies the brakes so the car has a large deceleration.

Give **two** possible risks of a large deceleration.

[2 marks]

1 _____

_____

2 _____

_____

13

Turn over for the next question