AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.3.2

Reaction time

Past-paper questions

Tier	**Higher**
Question groups	**10**
Available paper years	**2003–2022**

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:** _____

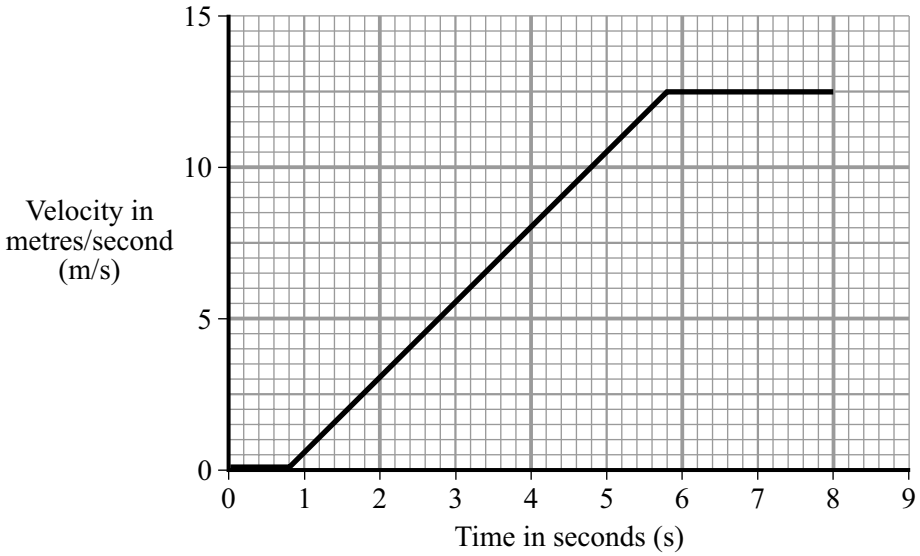
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.6.3.2 Reaction time

Question 01

June 2003 | 3451H | Original Q10 | Legacy

10 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....

(1 mark)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....

.....

Distance = ...metres

(3 marks)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

.....

.....

.....

Acceleration = ...

(4 marks)

4.5.6.3.2 Reaction time

Question 01 · continued

MARGIN BLANK

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....

.....

Force = ...newtons

(2 marks)

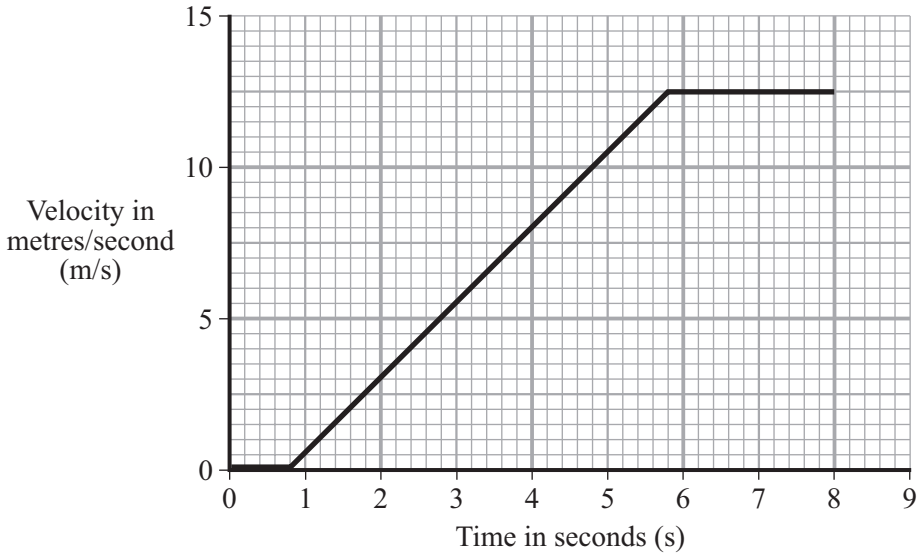
11

4.5.6.3.2 Reaction time

Question 02

June 2003 | 3462H3 | Original Q8 | Legacy

8 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....

(1 mark)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....

.....

Distance = ...metres

(3 marks)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

.....

.....

.....

Acceleration = ...

(4 marks)

4.5.6.3.2 Reaction time

Question 02 · continued

1 /

MARGIN BLANK

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....

.....

Force = ...newtons

(2 marks)

11

4.5.6.3.2 Reaction time

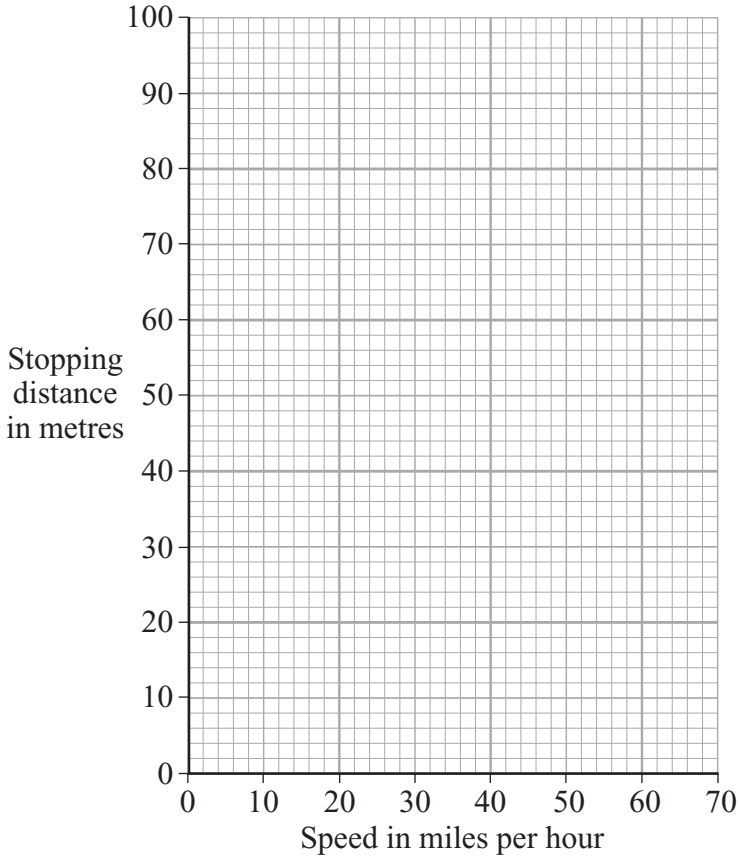
Question 03

June 2006 | 3451 | Original Q4 | Legacy

4 (a) The table shows how the stopping distance of a car, in metres (m), depends on the speed of the car, in miles per hour (mph).

Speed (mph)	20	30	40	50	60	70
Stopping distance (m)	12	23	36	53	73	96

(i) Draw a graph of stopping distance against speed.



(3 marks)

(ii) The speed limit outside a school is 20 mph.

Use the graph to estimate **how much further** a car will travel before it stops when driven at 25 mph instead of 20 mph.

Show clearly how you work out your answer.

.....

.....

(2 marks)

Question 4 continues on the next page

4.5.6.3.2 Reaction time

Question 03 · continued

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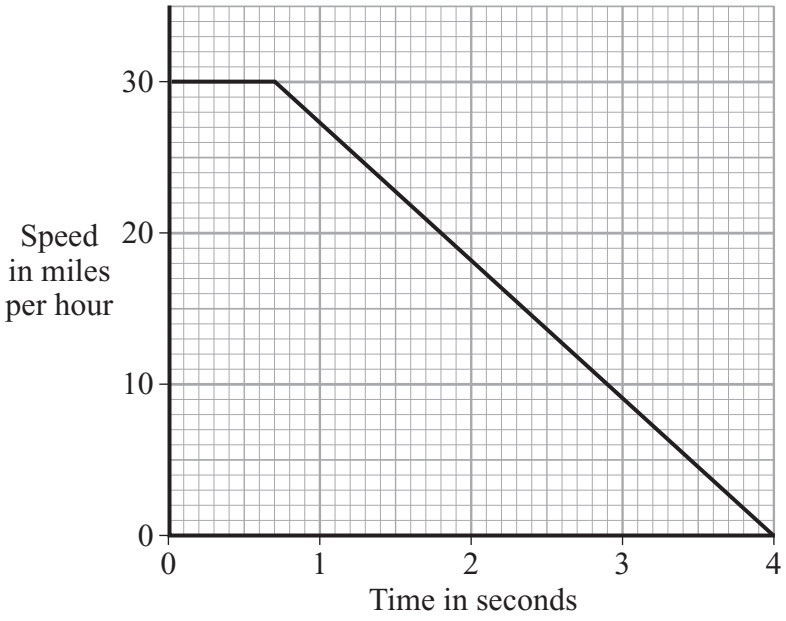
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(i) What was the driver's reaction time?

.....

(1 mark)

(ii) Describe the motion of the car during the first 0.5 seconds.

.....

(1 mark)

(iii) How long did it take the car to stop once the brakes were applied?

.....

(1 mark)

(iv) The drug cannabis makes the reactions of a person slower.

Explain how the stopping distance of the car would change if the driver had been smoking cannabis.

.....

.....

.....

.....

(2 marks)

4.5.6.3.2 Reaction time

Question 03 · continued

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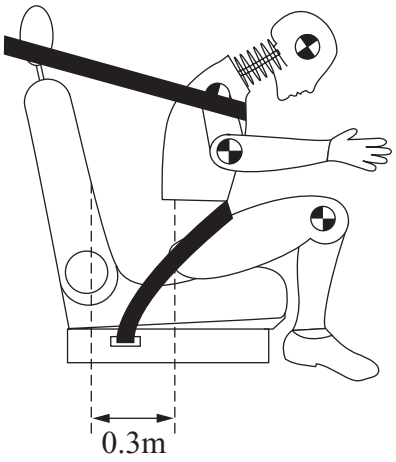
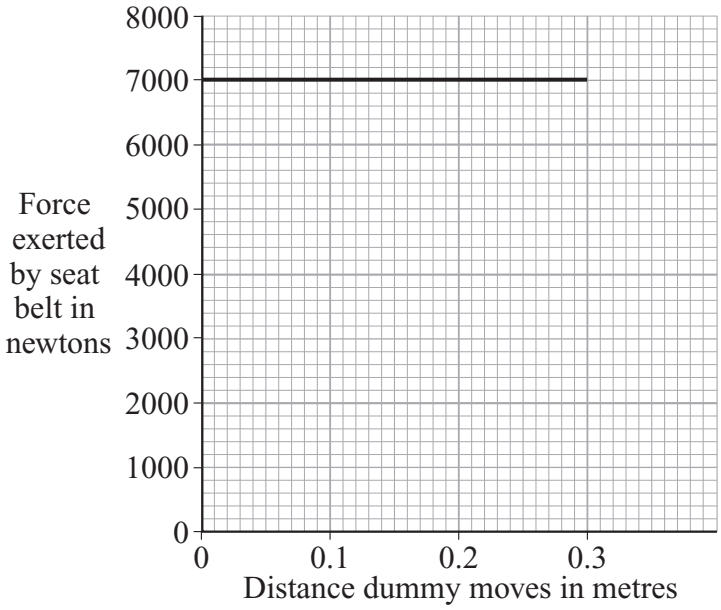
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to stop the dummy.

Show clearly how you work out your answer.

.....

.....

.....

Work done = ... joules

(2 marks)

(iii) How much energy is transferred from the dummy during the crash?

.....

(1 mark)

14

4.5.6.3.2 Reaction time

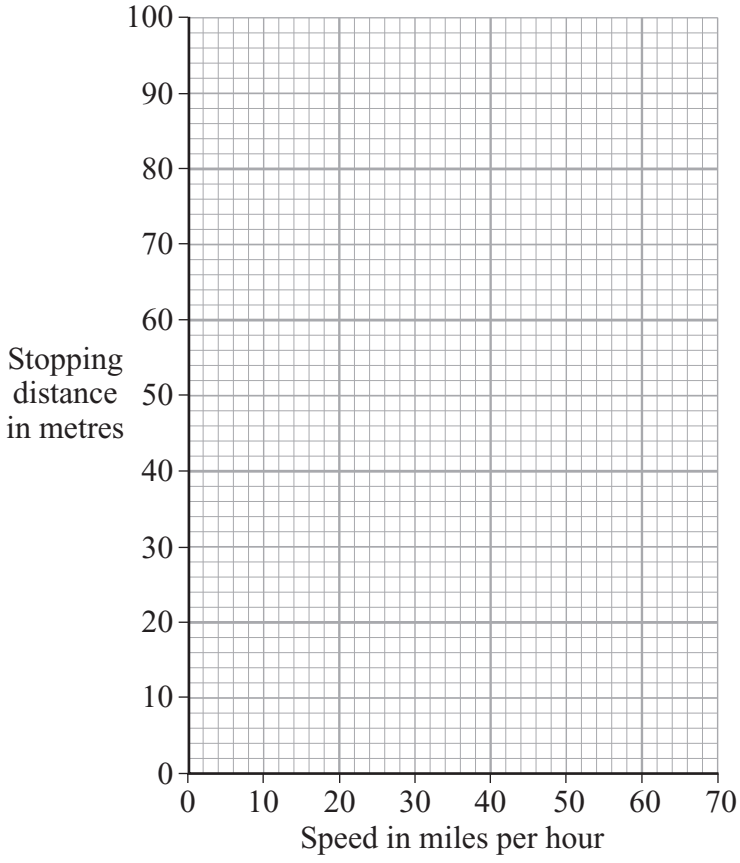
Question 04

June 2006 | 3462 | Original Q4 | Legacy

4 (a) The table shows how the stopping distance of a car, in metres (m), depends on the speed of the car, in miles per hour (mph).

Speed (mph)	20	30	40	50	60	70
Stopping distance (m)	12	23	36	53	73	96

(i) Draw a graph of stopping distance against speed.



(3 marks)

(ii) The speed limit outside a school is 20 mph.

Use the graph to estimate **how much further** a car will travel before it stops when driven at 25 mph instead of 20 mph.

Show clearly how you work out your answer.

.....

.....

(2 marks)

Question 4 continues on the next page

4.5.6.3.2 Reaction time

Question 04 · continued

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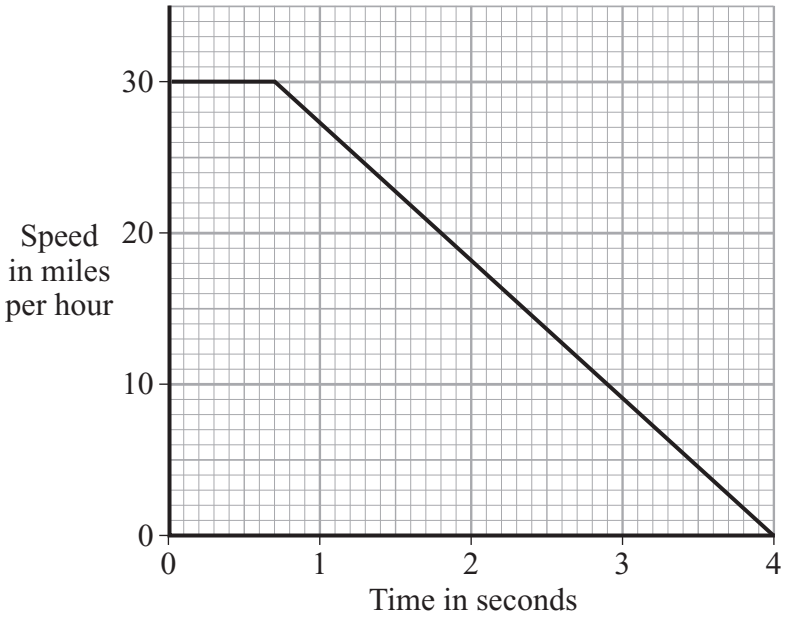
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(i) What was the driver's reaction time?

.....

(1 mark)

(ii) Describe the motion of the car during the first 0.5 seconds.

.....

(1 mark)

(iii) How long did it take the car to stop once the brakes were applied?

.....

(1 mark)

(iv) The drug cannabis makes the reactions of a person slower.

Explain how the stopping distance of the car would change if the driver had been smoking cannabis.

.....

.....

.....

.....

(2 marks)

4.5.6.3.2 Reaction time

Question 04 · continued

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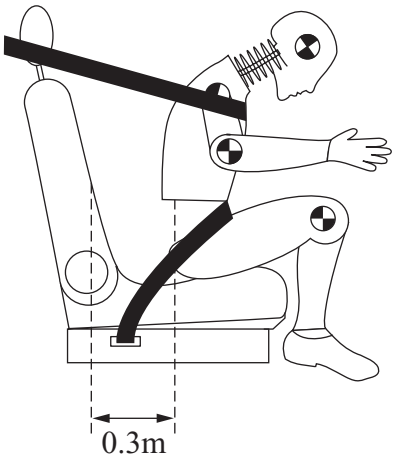
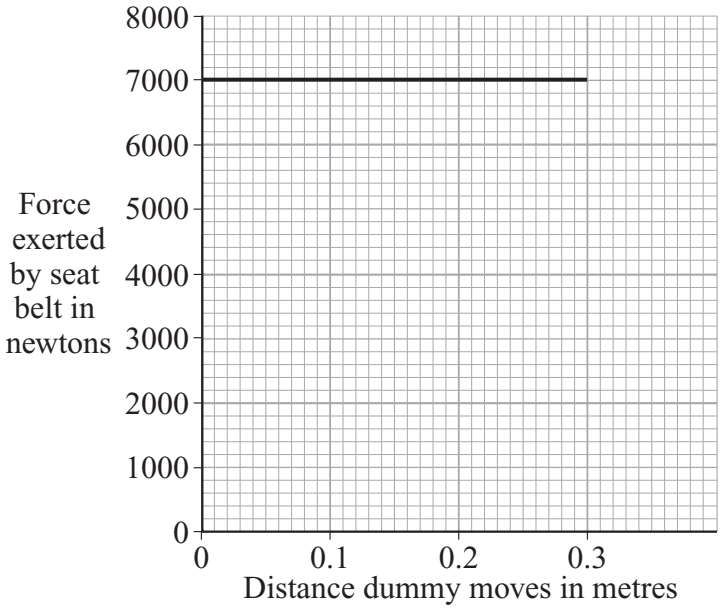
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to stop the dummy.

Show clearly how you work out your answer.

.....

.....

.....

Work done = ... joules

(2 marks)

(iii) How much energy is transferred from the dummy during the crash?

.....

(1 mark)

14

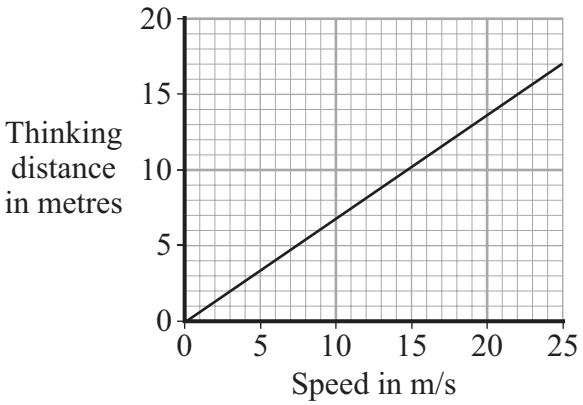
4.5.6.3.2 Reaction time

Question 05

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

4.5.6.3.2 Reaction time

Question 05 · 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

4.5.6.3.2 Reaction time

Question 06

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)

4.5.6.3.2 Reaction time

Question 06 · continued

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

4.5.6.3.2 Reaction time

Question 06 · 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.

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.....

(3 marks)

14

4.5.6.3.2 Reaction time

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]

.....

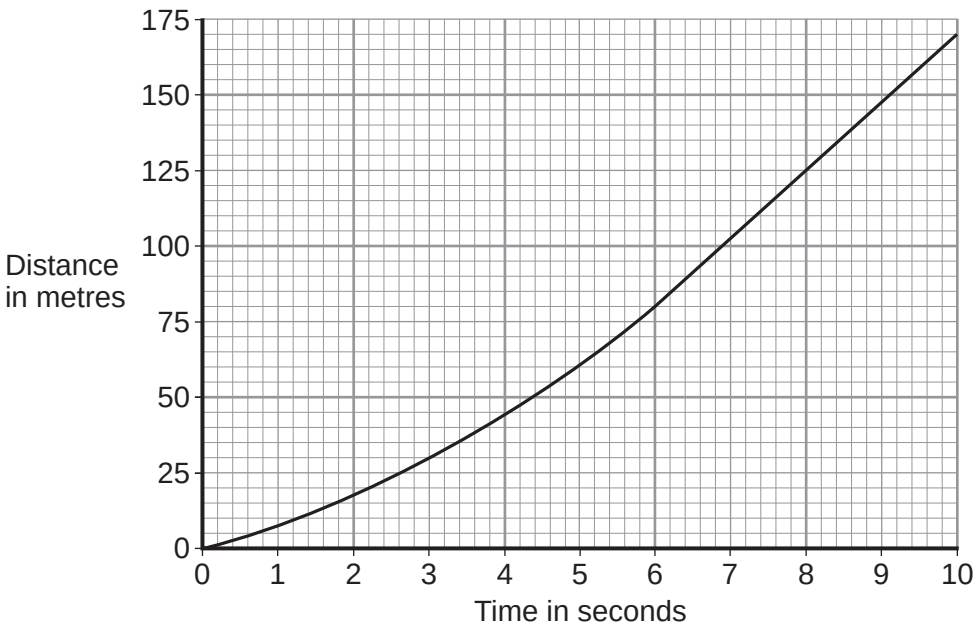
.....

Question 4 continues on the next page

4.5.6.3.2 Reaction time

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

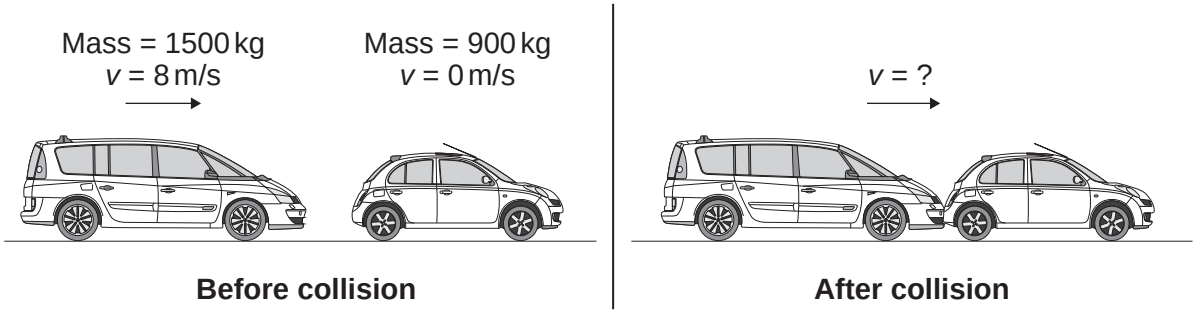
4.5.6.3.2 Reaction time

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]

.....

.....

.....

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.....

Velocity = ... m/s

Question 4 continues on the next page

4.5.6.3.2 Reaction time

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]

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13

4.5.6.3.2 Reaction time

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?

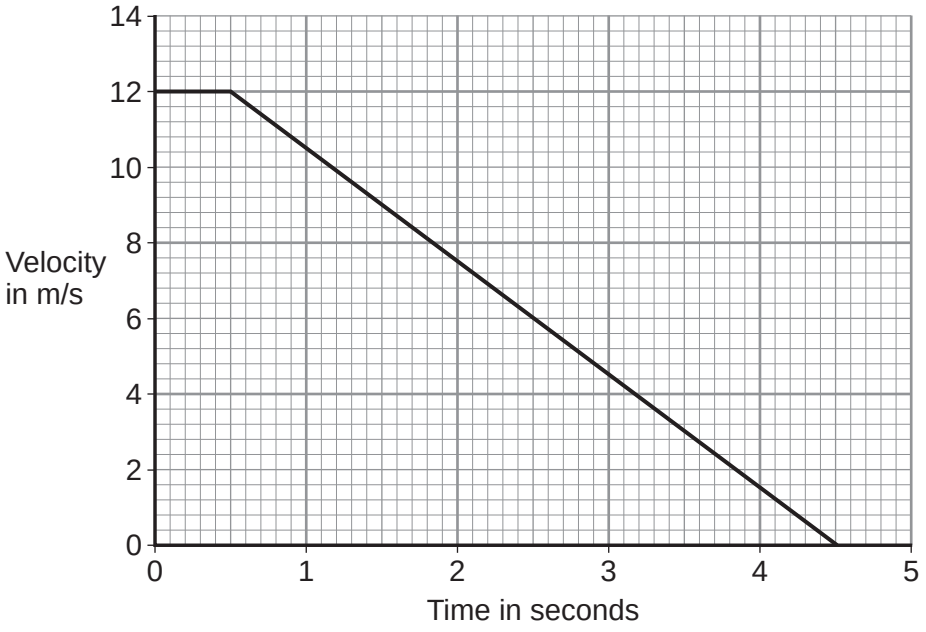
[1 mark]

_____

_____

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



4.5.6.3.2 Reaction time

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

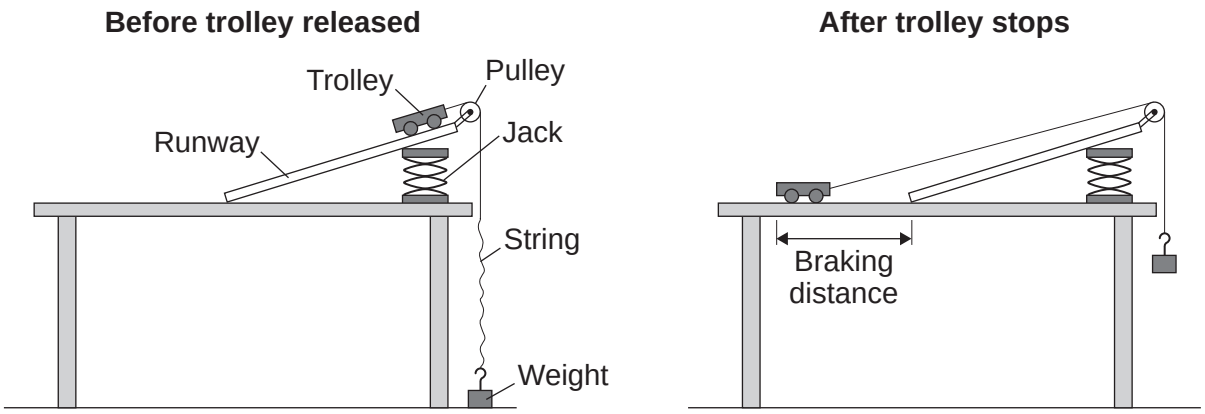
Question 4 continues on the next page

4.5.6.3.2 Reaction time

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]

4.5.6.3.2 Reaction time

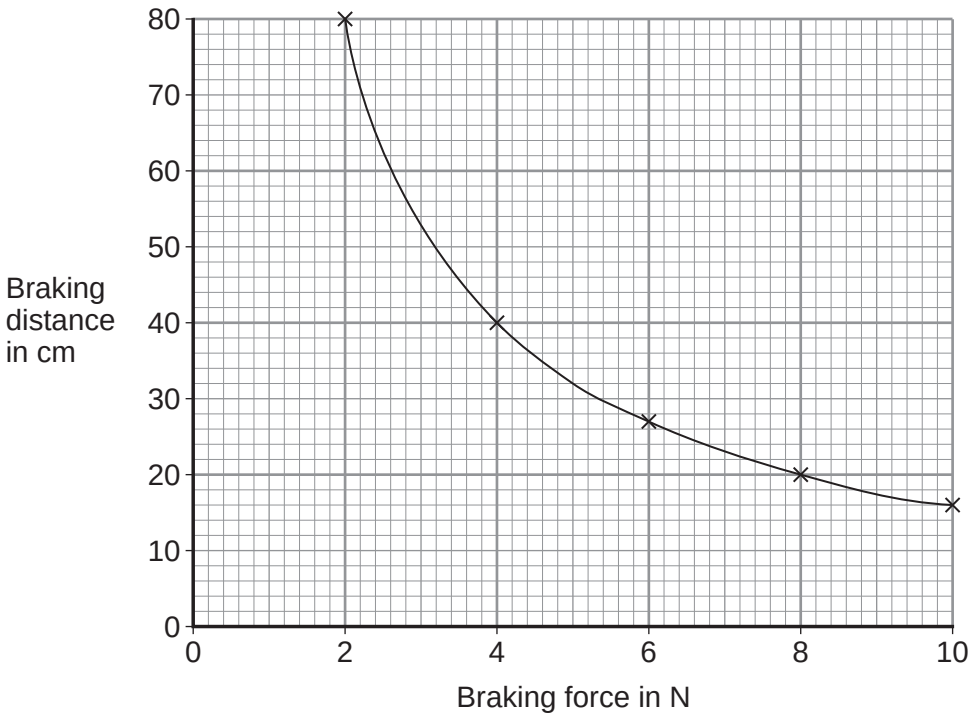
Question 08 · continued

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

4.5.6.3.2 Reaction time

Question 09

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

4.5.6.3.2 Reaction time

Question 09 · 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]

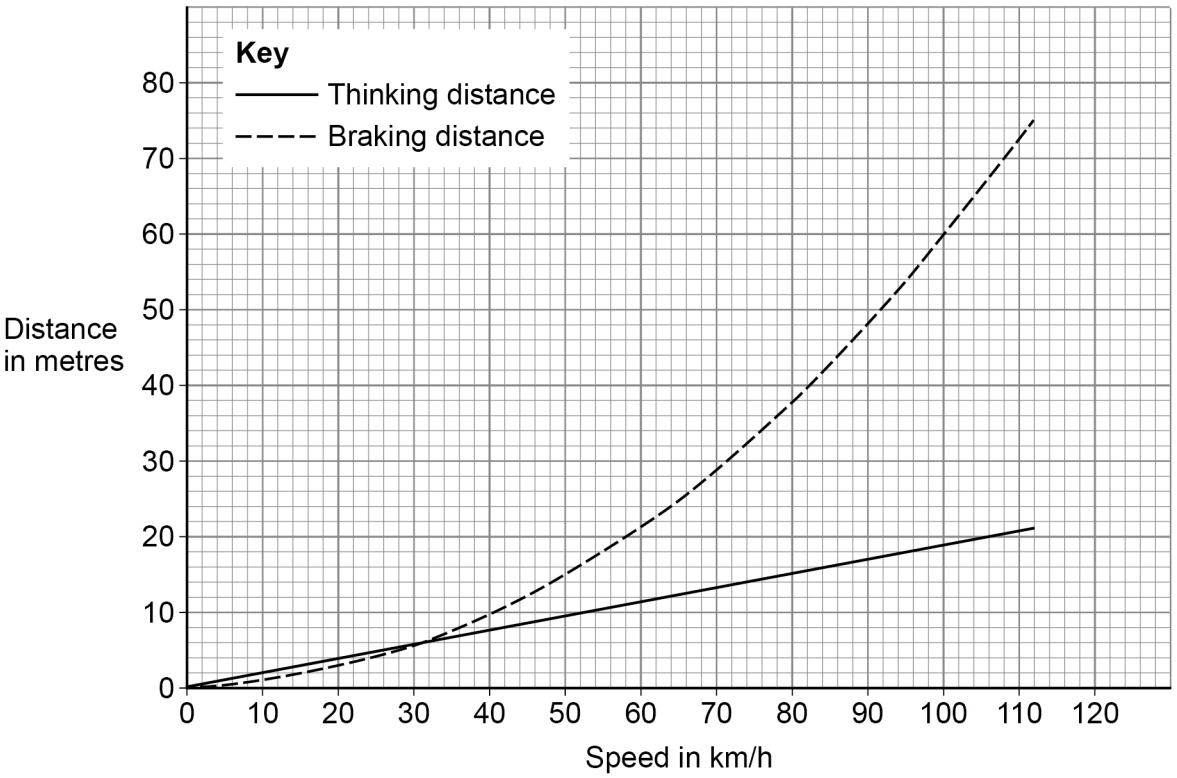
Deceleration = _____ m/s^2

4.5.6.3.2 Reaction time

Question 09 · 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

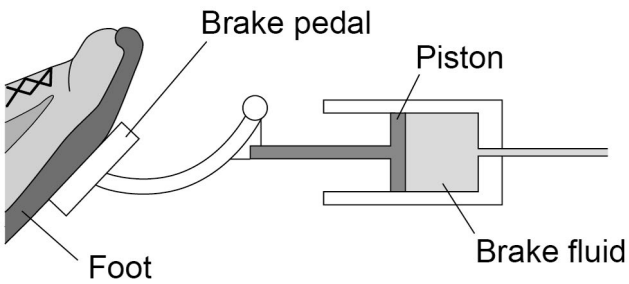
Question 1 continues on the next page

4.5.6.3.2 Reaction time

Question 09 · 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.

$p = F \times A$ ☐

$p = F \times A^2$ ☐

$p = \frac{F}{A}$ ☐

$p = \frac{A}{F}$ ☐

4.5.6.3.2 Reaction time

Question 09 · 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

4.5.6.3.2 Reaction time

Question 10

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]

_____

_____

_____

_____

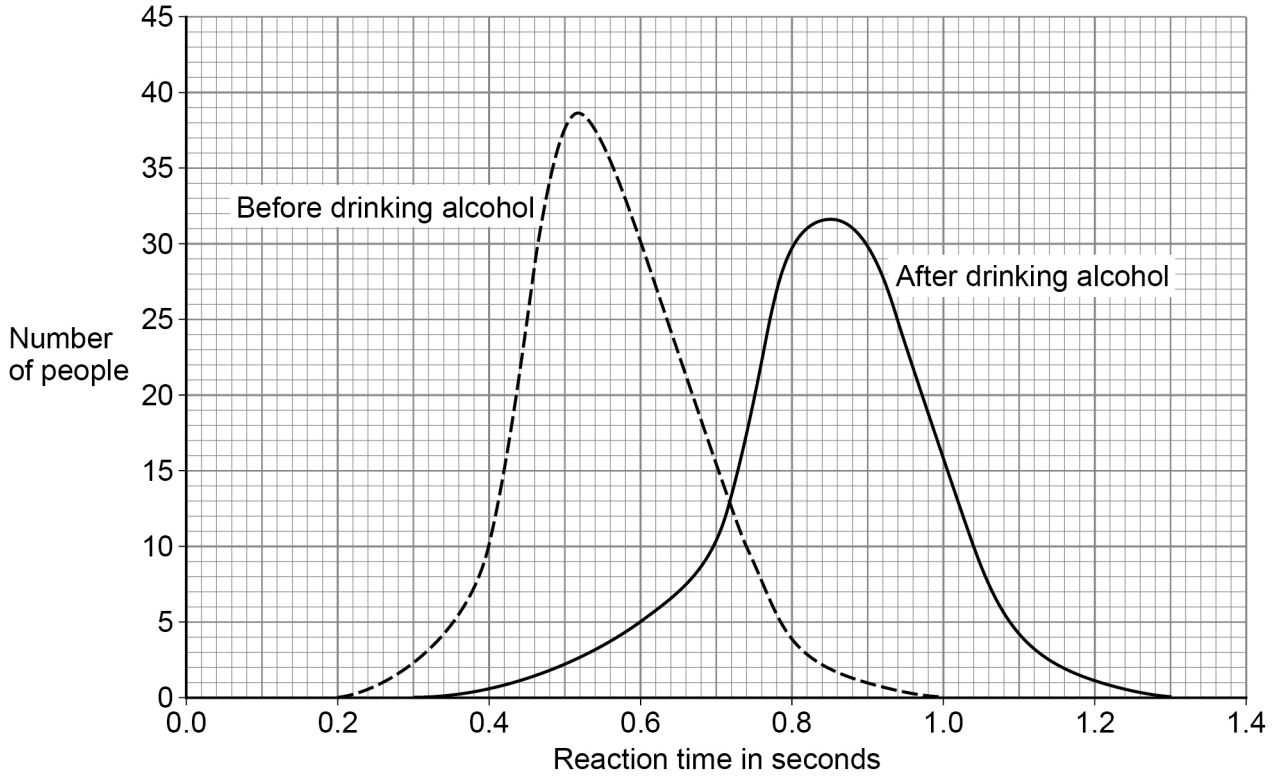
4.5.6.3.2 Reaction time

Question 10 · 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

4.5.6.3.2 Reaction time

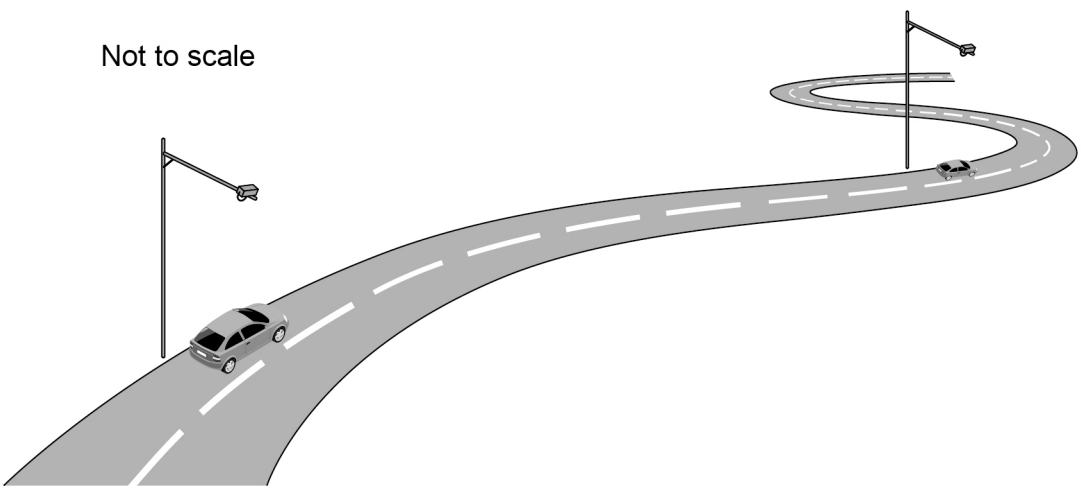
Question 10 · continued

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

4.5.6.3.2 Reaction time

Question 10 · 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