AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.3.2

Reaction time

Past-paper questions

Tier	**Foundation**
Question groups	**13**
Available paper years	**2003–2025**

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:** _____

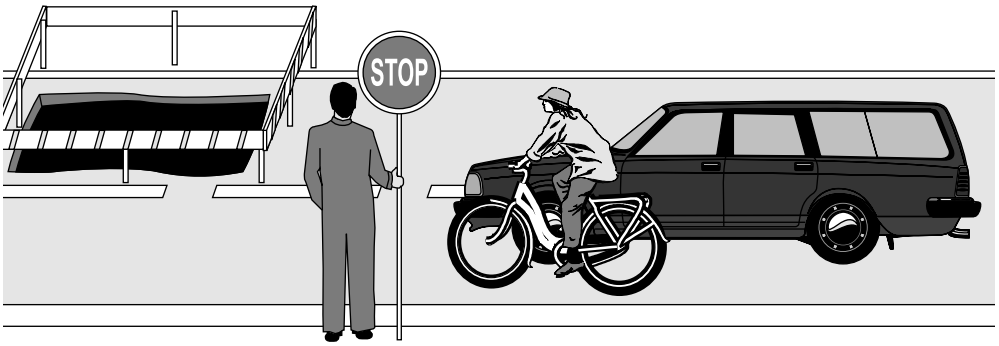
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.6.3.2 Reaction time

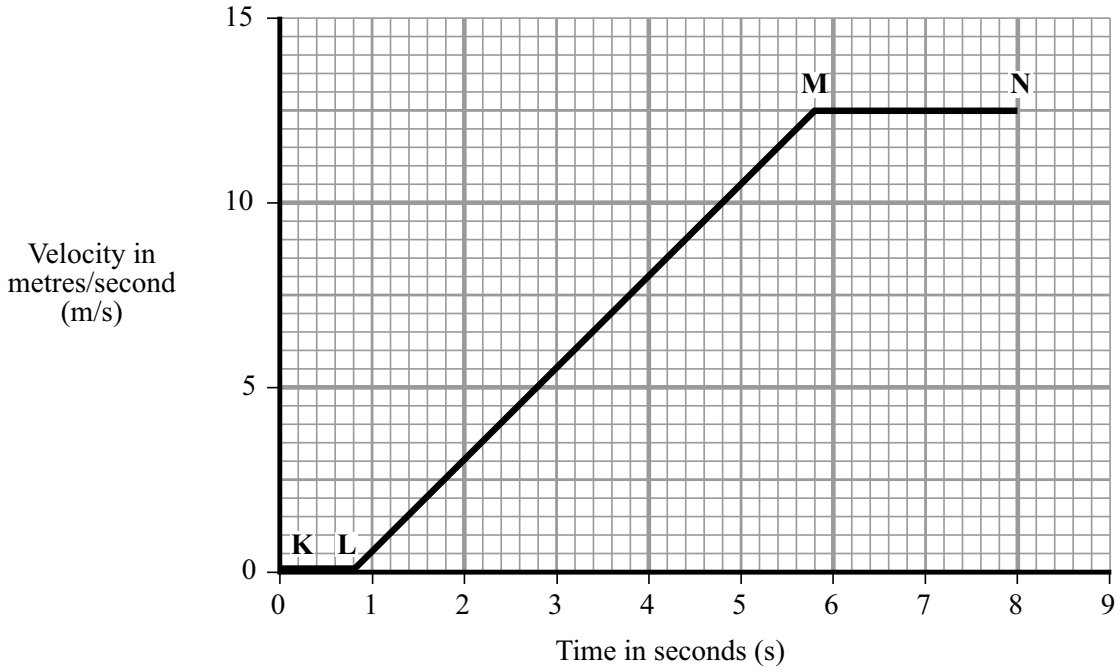
Question 01

June 2003 | 3451F | Original Q5 | Legacy

5 A car and a bicycle are travelling along a straight road. They have stopped at road works.



The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

.....

(1 mark)

(b) Between which two points on the graph is the car accelerating?

.....

(1 mark)

4.5.6.3.2 Reaction time

Question 01 · continued

MARGIN BLANK

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = ...seconds
(1 mark)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

(1 mark)

(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2 marks)

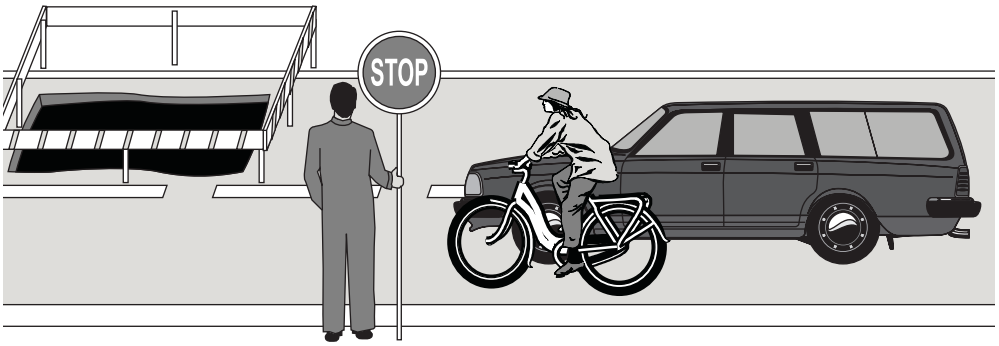
6

4.5.6.3.2 Reaction time

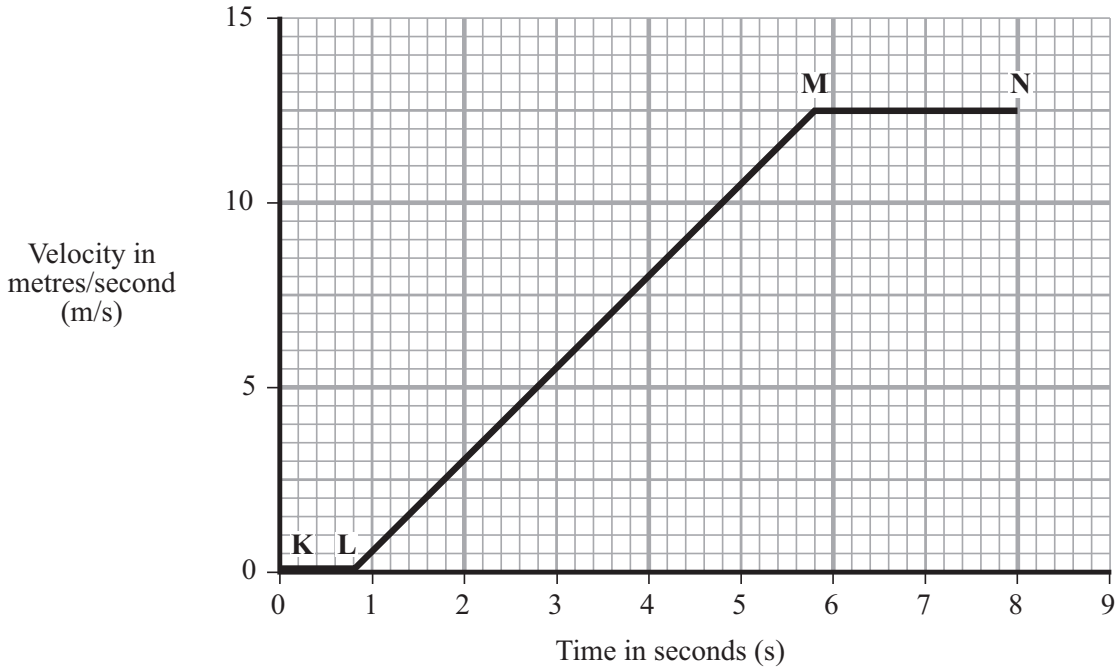
Question 02

June 2003 | 3462F3 | Original Q5 | Legacy

5 A car and a bicycle are travelling along a straight road. They have stopped at road works.



The graph shows how the velocity of the car changes after the sign is changed to GO.



(a) Between which two points on the graph is the car moving at constant velocity?

.....

(1 mark)

(b) Between which two points on the graph is the car accelerating?

.....

(1 mark)

4.5.6.3.2 Reaction time

Question 02 · continued

MARGIN BLANK

(c) Between the sign changing to GO and the car starting to move, there is a time delay. This is called the reaction time.

(i) What is the reaction time of the car driver?

Reaction time = ...seconds
(1 mark)

(ii) Which **one** of the following could increase the reaction time of a car driver? Tick the box next to your choice.

Drinking alcohol ☐

Wet roads ☐

Worn car brakes ☐

(1 mark)

(d) The cyclist starts to move at the same time as the car. For the first 2 seconds the cyclist's acceleration is constant and is greater than that of the car.

Draw a line on the graph to show how the velocity of the cyclist might change during the first 2 seconds of its motion.

(2 marks)

6

4.5.6.3.2 Reaction time

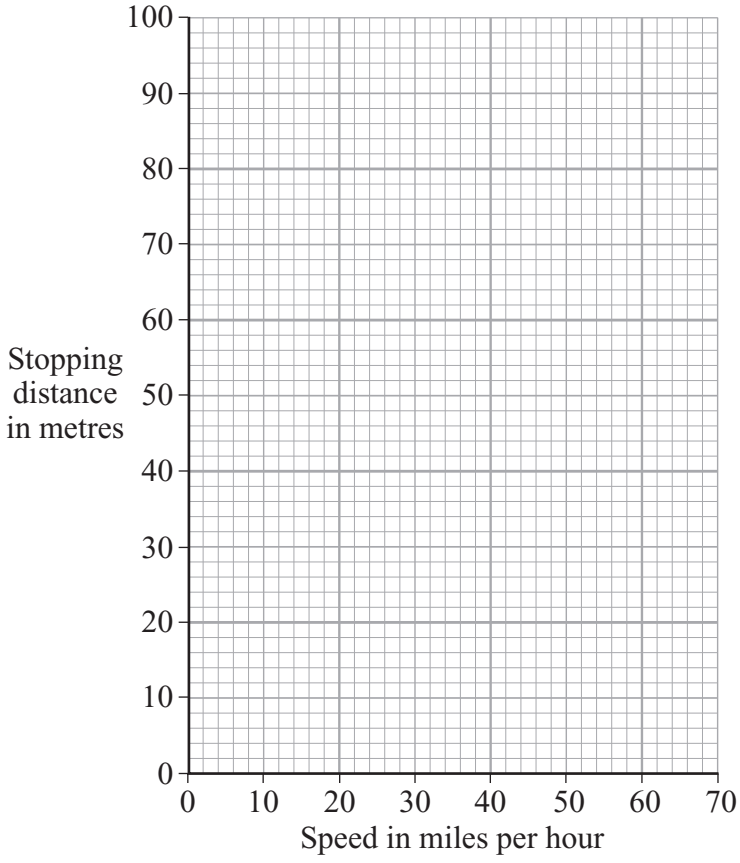
Question 03

June 2006 | 3451 | Original Q15 | Legacy

15 (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 15 continues on the next page

Question 03 · continued

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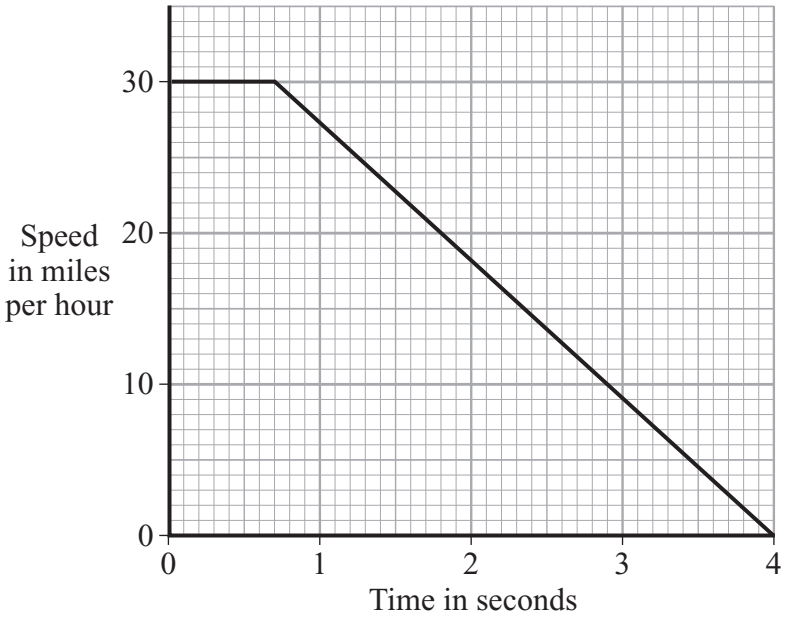
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



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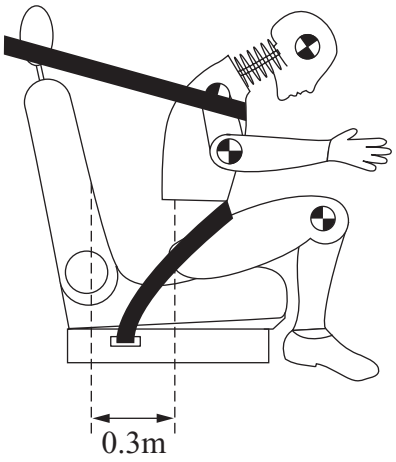
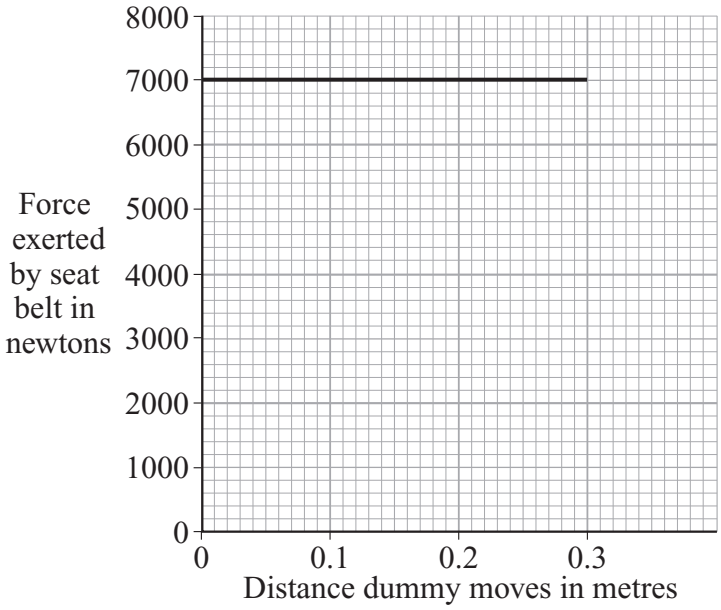
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(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

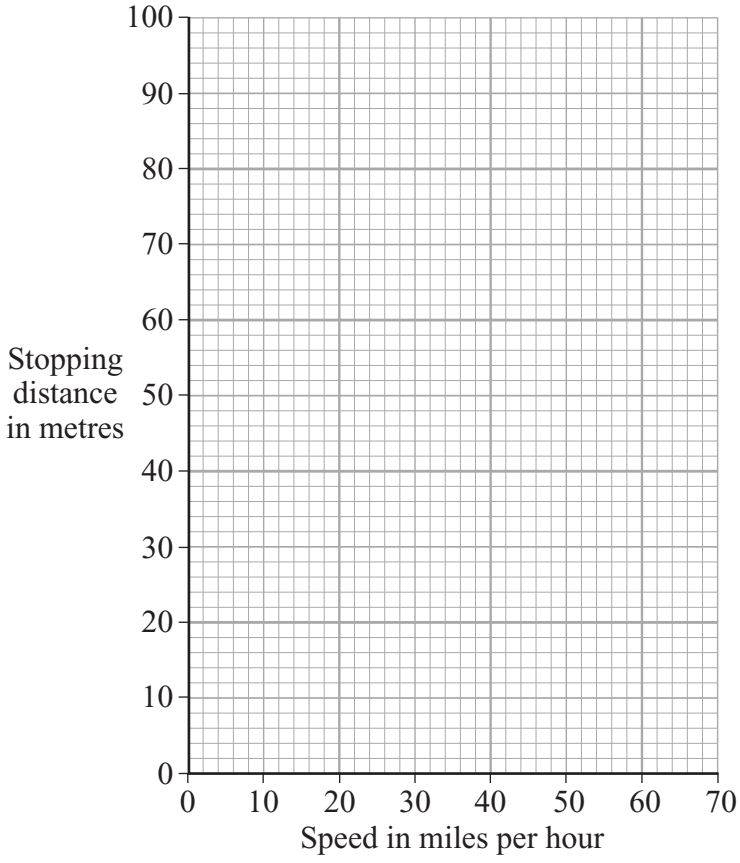
Question 04

June 2006 | 3462 | Original Q13 | Legacy

13 (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 13 continues on the next page

4.5.6.3.2 Reaction time

Question 04 · continued

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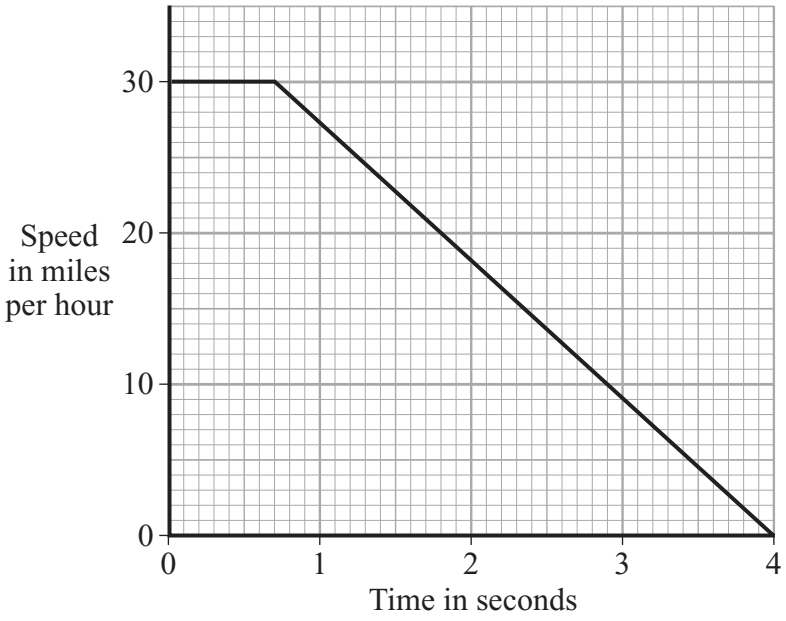
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



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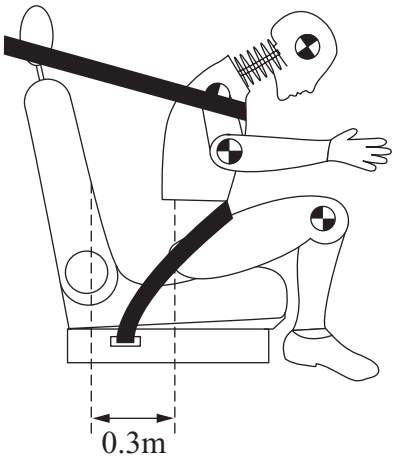
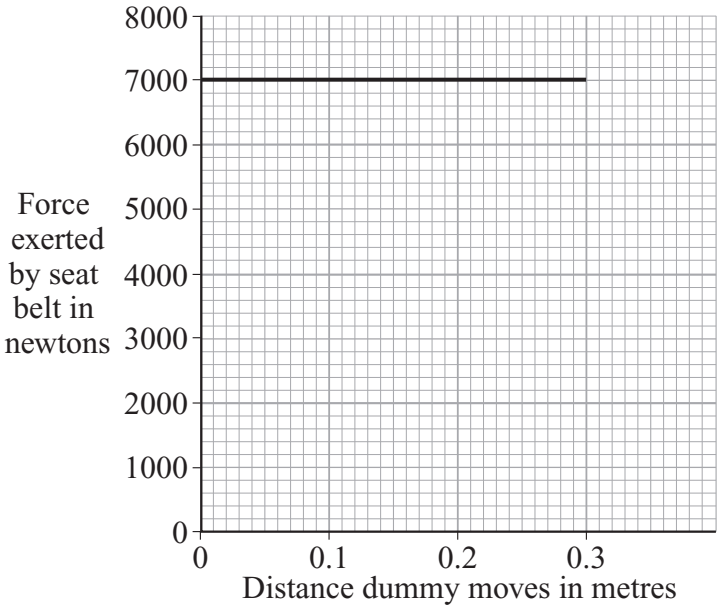
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(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)

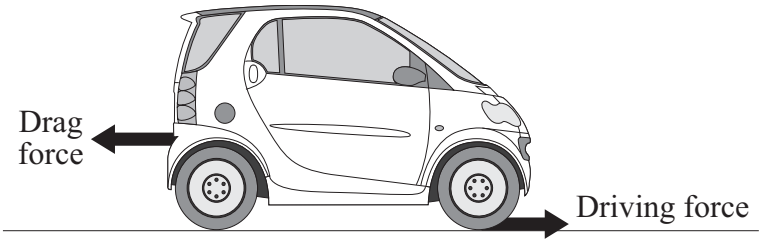
14

4.5.6.3.2 Reaction time

Question 05

January 2008 | PHY2F | Original Q3 | Legacy

3 The diagram shows the horizontal forces acting on a car travelling along a straight road.



(a) Complete the following sentences by drawing a ring around the correct word in each box.

(i) When the driving force equals the drag force, the speed of the car is

decreasing
constant
increasing

.

(1 mark)

(ii) Putting the brakes on transforms the car's kinetic energy mainly into

heat
light
sound

.

(1 mark)

4.5.6.3.2 Reaction time

Question 05 · continued

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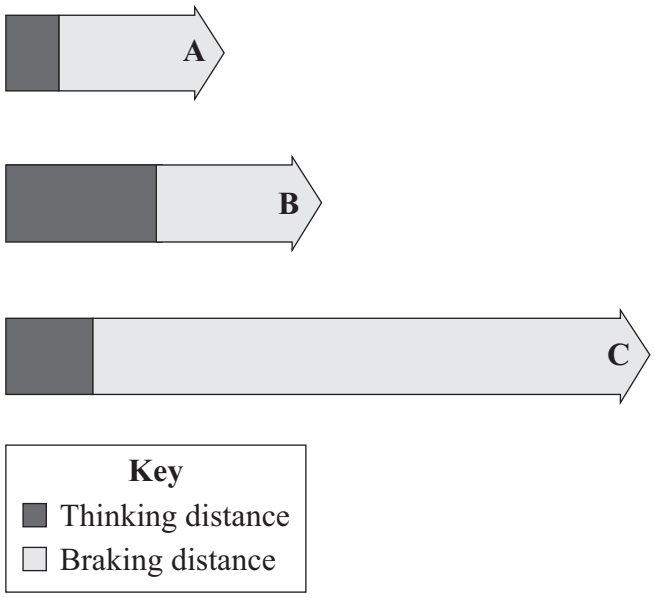
(b) The charts, **A**, **B** and **C** give the thinking distance and the braking distance for a car driven under different conditions.

(i) Draw straight lines to match each chart to the correct conditions.

Draw only **three** lines.

Conditions	Charts
Speed = 22 m/s driver wide awake	
Speed = 13 m/s driver wide awake	
Speed = 13 m/s driver very tired	



(2 marks)

(ii) The three charts above all apply to dry road conditions.

How would the braking distances be different if the road were wet?

.....

.....

(1 mark)

5

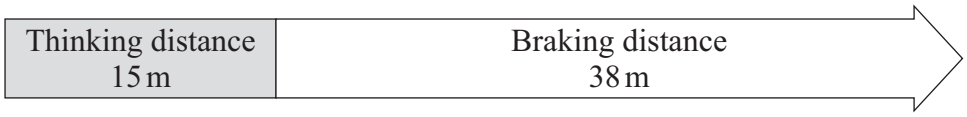
4.5.6.3.2 Reaction time

Question 06

June 2008 | PHY2F | Original Q1 | Legacy

1 (a) A car driver makes an emergency stop.

The chart shows the 'thinking distance' and the 'braking distance' needed to stop the car.



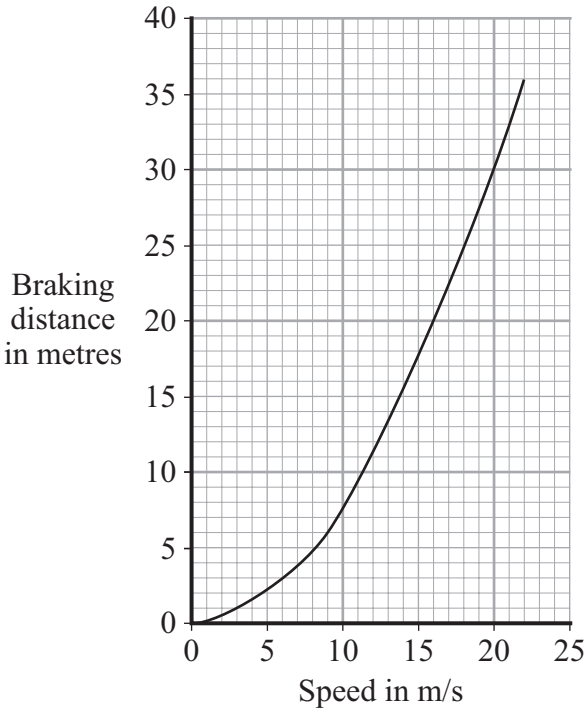
Calculate the total stopping distance of the car.

.....

Stopping distance = ... m

(1 mark)

1 (b) The graph shows how the braking distance of a car driven on a dry road changes with the car's speed.



The braking distance of the car on an icy road is longer than the braking distance of the car on a dry road.

1 (b) (i) Draw a new line on the graph to show how the braking distance of the car on an icy road changes with speed.

(2 marks)

Question 1 continues on the next page

4.5.6.3.2 Reaction time

Question 06 · continued

for mark

1 (b) (ii) Which **two** of the following would also increase the braking distance of the car?

Put a tick (✓) in the box next to each of your answers.

rain on the road ☐

the driver having drunk alcohol ☐

car brakes in bad condition ☐

the driver having taken drugs ☐

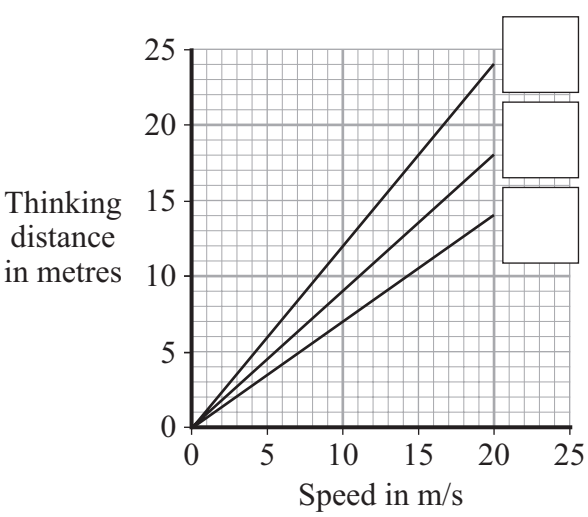
(2 marks)

1 (c) The thinking distance depends on the driver's reaction time.

The table shows the reaction times of three people driving under different conditions.

Car driver	Condition	Reaction time in seconds
A	Wide awake with no distractions	0.7
B	Using a hands-free mobile phone	0.9
C	Very tired and listening to music	1.2

The graph lines show how the thinking distance for the three drivers, **A**, **B** and **C**, depends on how fast they are driving the car.



1 (c) (i) Match each graph line to the correct driver by writing **A**, **B** or **C** in the box next to the correct line.

(2 marks)

4.5.6.3.2 Reaction time

Question 06 · continued

for mark

1 (c) (ii) The information in the table cannot be used to tell if driver **C**'s reaction time is increased by being tired **or** by listening to music.

Explain why.

.....

.....

.....

.....

(2 marks)

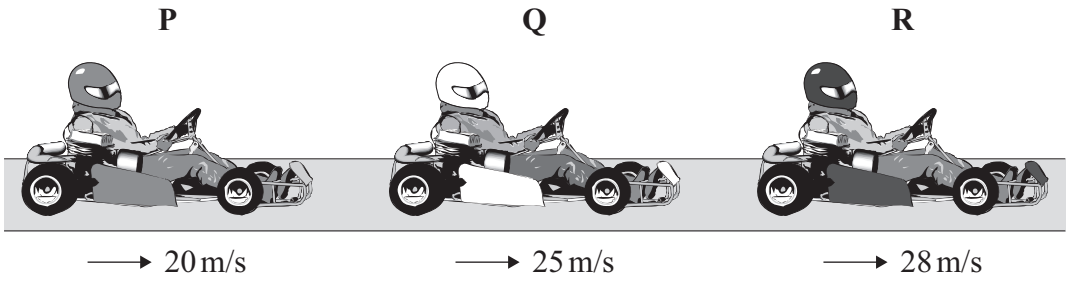
9

Turn over for the next question

4.5.6.3.2 Reaction time

Question 07

3 (a) The diagram shows three identical go-karts, **P**, **Q** and **R**, travelling at different speeds along the straight part of an outdoor racetrack.



Which **go-kart**, **P**, **Q** or **R**, has the greatest momentum?

.....

Give the reason for your answer.

.....

.....

(2 marks)

3 (b) The total mass of go-kart **Q** and the driver is 130 kg.

3 (b) (i) Use the equation in the box to calculate the total momentum of go-kart **Q** and the driver.

momentum = mass × velocity

Show clearly how you work out your answer.

.....

.....

Momentum = ...

(2 marks)

3 (b) (ii) Which of the following is the unit of momentum?

Draw a ring around your answer.

J/s	**kg m/s**	**Nm**

(1 mark)

4.5.6.3.2 Reaction time

Question 07 · continued

for mark

3 (c) To race safely at high speed, a go-kart driver must have fast reaction times and the outdoor racetrack should be dry.

3 (c) (i) How would being tired affect a driver's reaction time?

.....

(1 mark)

3 (c) (ii) How would a wet track affect the braking distance of a go-kart?

.....

(1 mark)

7

Turn over for the next question

4.5.6.3.2 Reaction time

Question 08

June 2010 | PHY2F | Original Q3 | Legacy

3 (a) The total stopping distance of a car has two parts. One part is the distance the car travels during the driver's reaction time. This distance is often called the 'thinking distance'.

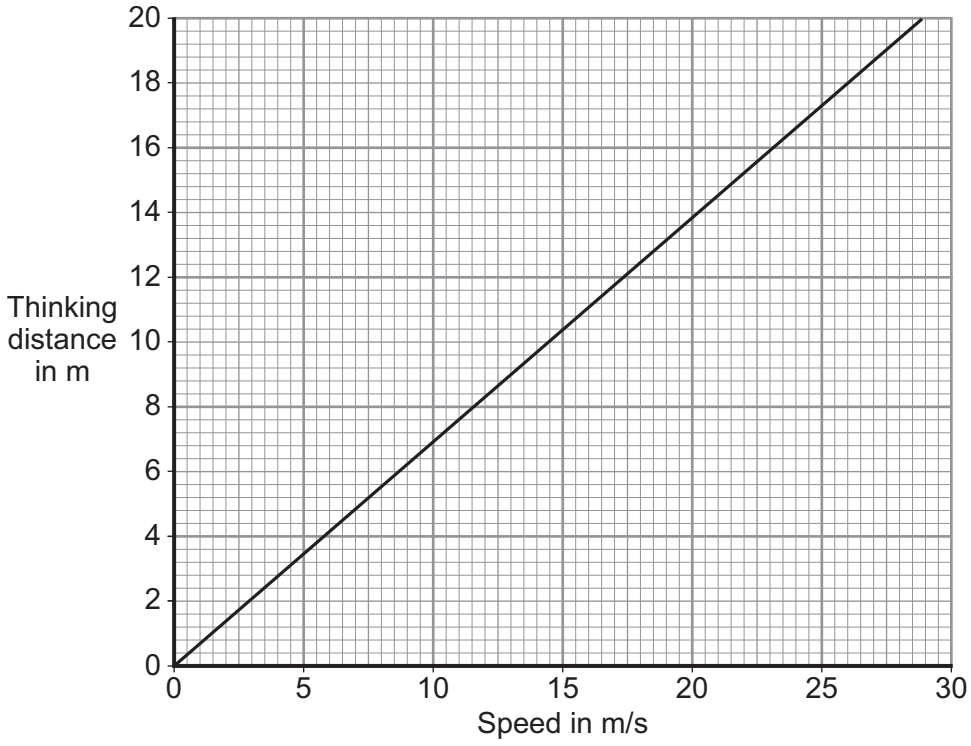
What distance is added to the 'thinking distance' to give the total stopping distance?

.....

.....

(1 mark)

3 (b) The graph shows the relationship between the speed of a car and the thinking distance.



Describe the relationship between speed and thinking distance.

.....

.....

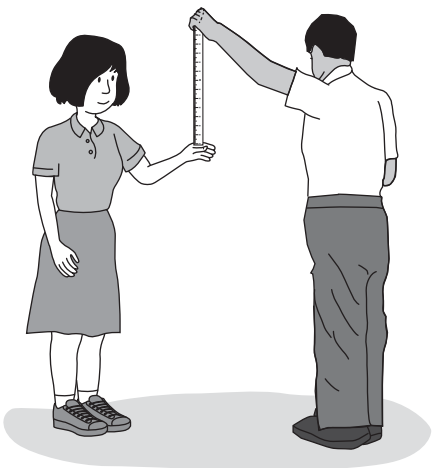
(2 marks)

Question 3 continues on the next page

4.5.6.3.2 Reaction time

Question 08 · continued

3 (c) The diagram shows two students investigating reaction time.



One student holds a 30 cm ruler, then lets go. As soon as the second student sees the ruler fall, she closes her hand, stopping the ruler. The further the ruler falls before being stopped, the slower her reaction time.

3 (c) (i) One student always holds the ruler the same distance above the other student's hand. In this experiment, what type of variable is this?

Put a tick (✓) in the box next to your answer.

independent variable ☐

dependent variable ☐

control variable ☐

(1 mark)

3 (c) (ii) Describe how this experiment could be used to find out whether listening to music affects reaction time.

.....

.....

.....

.....

(2 marks)

4.5.6.3.2 Reaction time

3 (d) The following information is written on the label of some cough medicine.

WARNING: Causes drowsiness.
Do not drive or operate machinery.

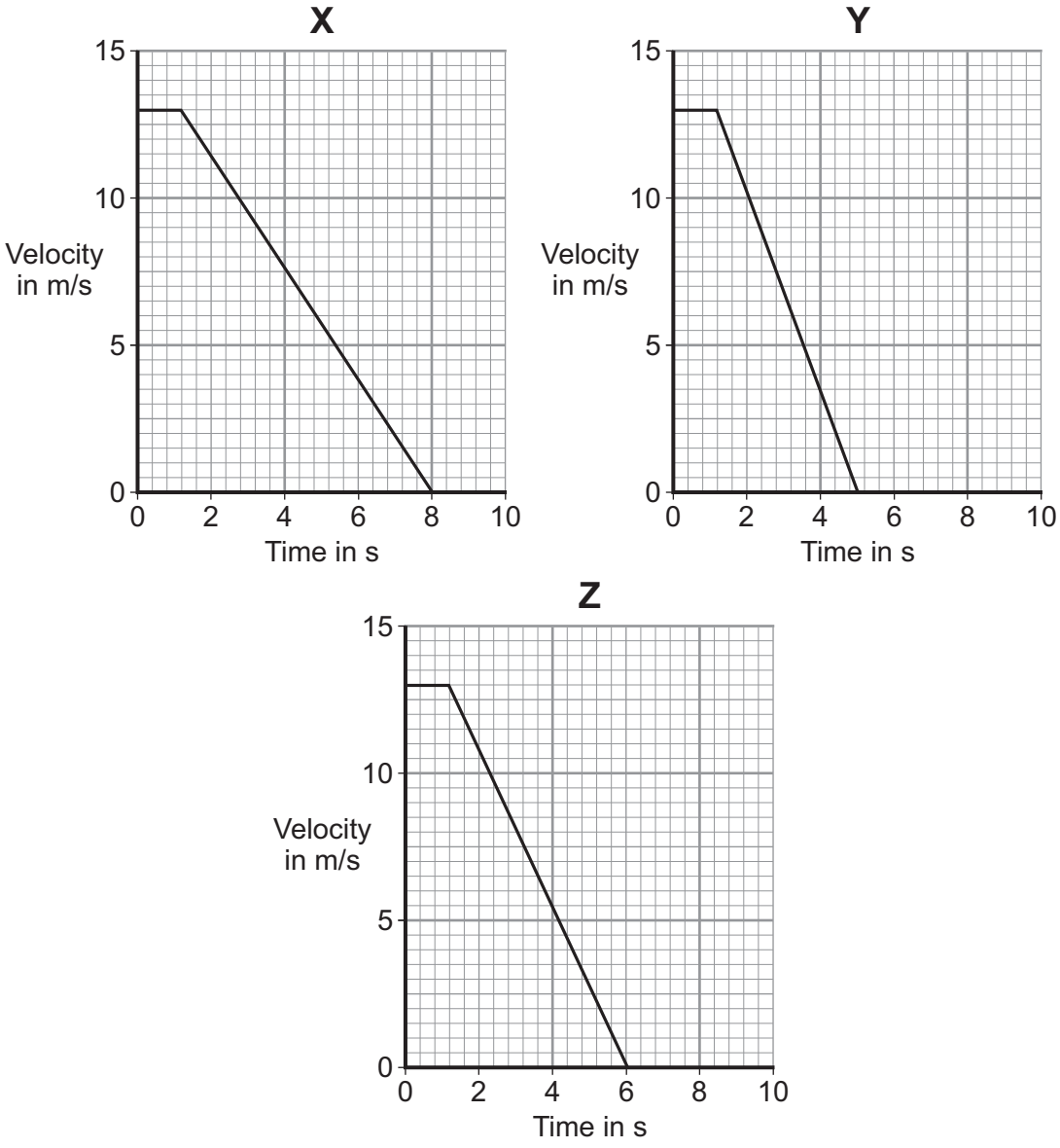
How is feeling drowsy (sleepy) likely to affect a driver's reaction time?

.....

.....

(1 mark)

3 (e) Three cars, **X**, **Y** and **Z**, are being driven along a straight road towards a set of traffic lights. The graphs show how the velocity of each car changes once the driver sees that the traffic light has turned to red.



Which one of the cars, **X**, **Y** or **Z**, stops in the shortest distance?

.....

(1 mark)

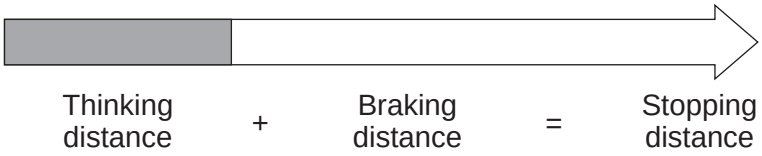
8

4.5.6.3.2 Reaction time

Question 09

June 2013 | PH2FP | Original Q6 | Legacy

6 The diagram shows how the thinking distance and braking distance of a car add together to give the stopping distance of the car.



6 (a) Use words from the box to complete the sentence.

distance	**energy**	**force**	**time**

The stopping distance is found by adding the distance the car travels during the driver's reaction ..... and the distance the car travels under the braking ..... . *(2 marks)*

6 (b) Which **one** of the following would **not** increase the thinking distance?

Tick (✓) **one** box.

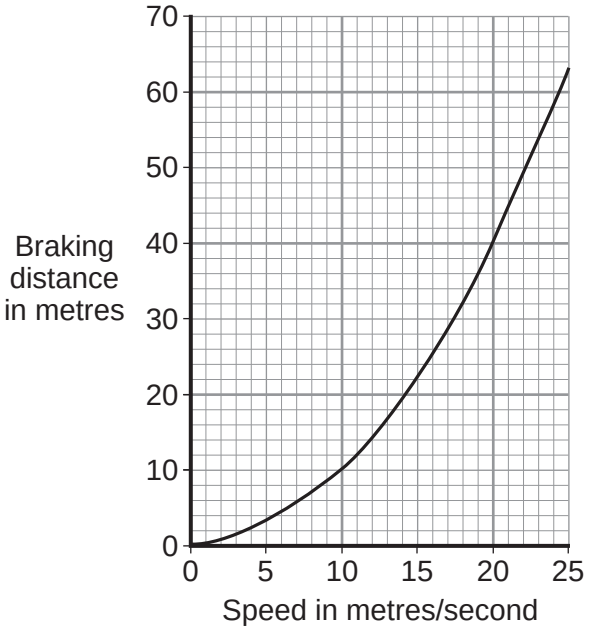
The car driver being tired. ☐

The car tyres being badly worn. ☐

The car being driven faster. ☐

(1 mark)

6 (c) The graph shows how the braking distance of a car changes with the speed of the car. The force applied to the car brakes does not change.



4.5.6.3.2 Reaction time

Question 09 · continued June 2013 | PH2FP | Original Q6 | Legacy

6 (c) (i) What conclusion about braking distance can be made from the graph?

.....

.....

.....

.....

(2 marks)

6 (c) (ii) The graph is for a car driven on a dry road.

Draw a line on the graph to show what is likely to happen to the braking distance at different speeds if the same car was driven on an icy road.

(1 mark)

6 (d) A local council has reduced the speed limit from 30 miles per hour to 20 miles per hour on a few roads. The reason for reducing the speed limit was to reduce the number of accidents.

6 (d) (i) A local newspaper reported that a councillor said:

"It will be much safer because drivers can react much faster when driving at 20 miles per hour than when driving at 30 miles per hour."

This statement is wrong. Why?

.....

.....

(1 mark)

6 (d) (ii) The local council must decide whether to introduce the lower speed limit on a lot more roads.

What evidence should the local council collect to help make this decision?

.....

.....

.....

.....

(2 marks)

9

4.5.6.3.2 Reaction time

Question 10

2 A car driver sees the traffic lights ahead change to red. The driver applies the brakes to stop the car.

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

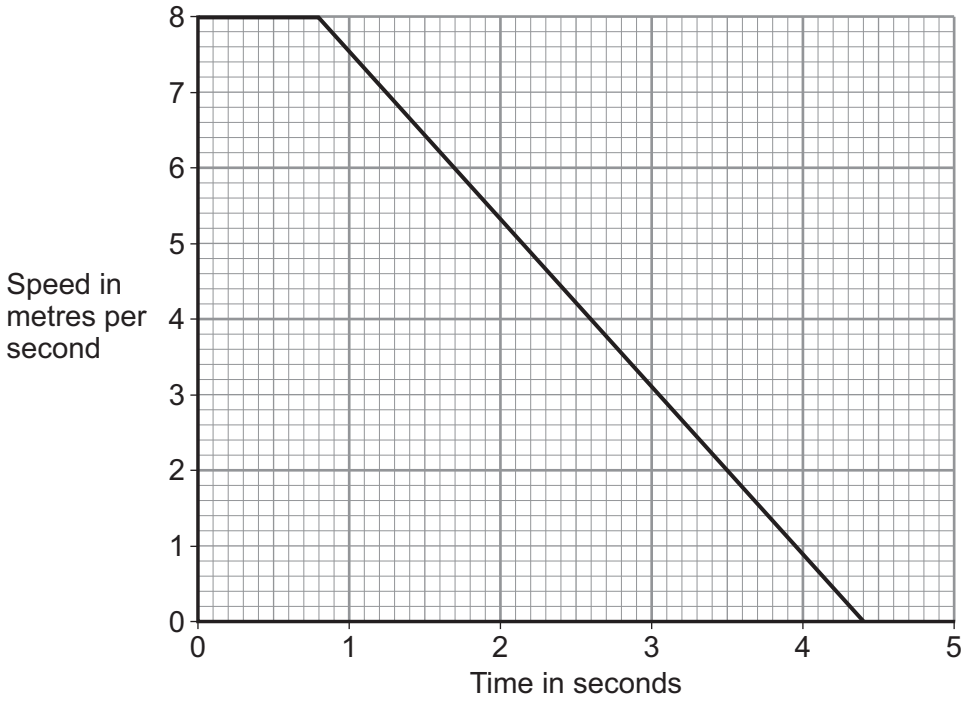
2 (a) Draw **one** line from each distance to the description of that distance.

[2 marks]

Distance	Description
Stopping	The distance the car moves between the brakes being applied and the car stopping.
Braking	The distance the car moves between the driver seeing the red light and the car stopping.
	The distance the car moves between the driver seeing the red light and applying the brakes.

2 (b) **Figure 3** shows how the speed of the car changes from the instant that the driver sees the traffic lights change to red.

Figure 3



4.5.6.3.2 Reaction time

Question 10 · continued

2 (b) (i) What is the reaction time of the driver?

[1 mark]

Tick (✓) **one** box.

0.8 s ☐ 3.6 s ☐ 4.4 s ☐

2 (b) (ii) Using a mobile phone while driving may increase the reaction time of the driver.

Explain the effect of an increased reaction time on the stopping distance of the car.

[2 marks]

_____

_____

_____

_____

2 (b) (iii) The car has a mass of 750 kg

How is the kinetic energy of the car calculated when the car is travelling at 8 m/s?

[1 mark]

Tick (✓) **one** box.

$\frac{1}{2} \times 750 \times 8$ ☐

$\frac{1}{2} \times 750 \times 8^2$ ☐

$\frac{1}{2} \times 750^2 \times 8^2$ ☐

2 (b) (iv) Use the correct answers from the box to complete the sentence.

Each answer may be used once, more than once or not at all.

[2 marks]

decreases	**does not change**	**increases**

When the brakes of the car are applied,

the kinetic energy of the car _____ and

the temperature of the brakes _____ .

8

4.5.6.3.2 Reaction time

Question 11

November 2021 | 8463/2F | Original Q8

0 8 The thinking distance and braking distance for a car vary with the speed of the car.

0 8 . 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 8 continues on the next page

4.5.6.3.2 Reaction time

Question 11 · continued

0 8 . 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 8 . 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.

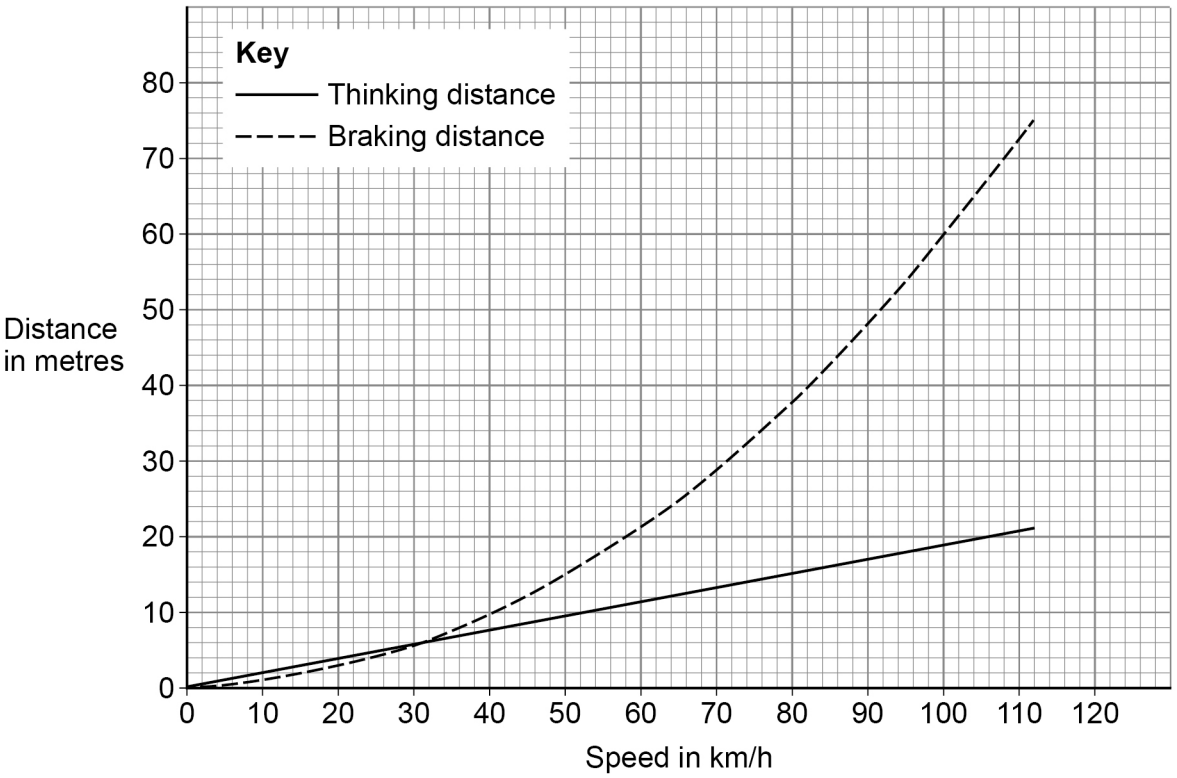
[3 marks]

Deceleration = _____ m/s^2

4.5.6.3.2 Reaction time

0 8 . 4 **Figure 18** shows how the thinking distance and braking distance for a car vary with the speed of the car.

Figure 18



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

[2 marks]

Stopping distance = _____ m

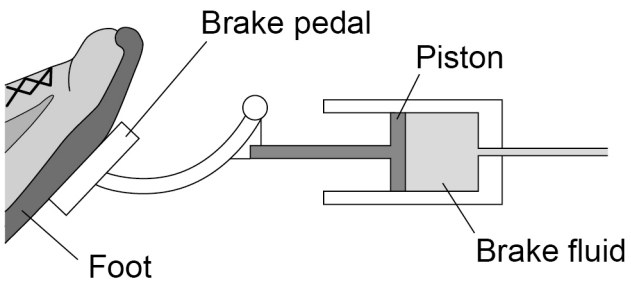
Question 8 continues on the next page

4.5.6.3.2 Reaction time

Question 11 · continued

Figure 19 shows part of the braking system for a car.

Figure 19



0 8 . 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 11 · continued

0 8 . 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 12

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0 2 The stopping distance of a car is the braking distance added to the thinking distance.

0 2 . 1 Complete the sentences.

Choose answers from the box.

[2 marks]

chemical	**electrostatic**	**kinetic**
nuclear		**thermal**

A driver applies the brakes to a moving car.

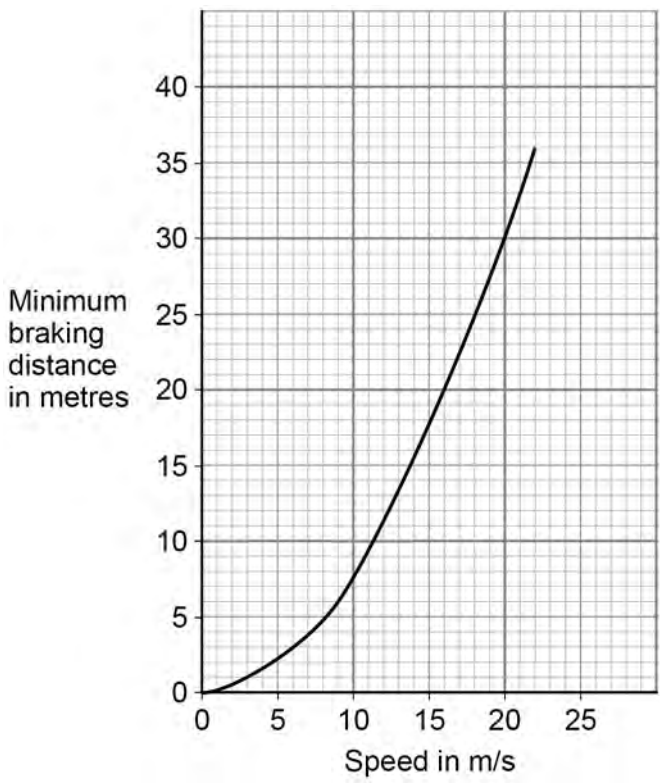
As the car slows down, there is a decrease in the _____ energy of the car.

The work done by friction causes an increase in the _____ energy store of the brakes.

Question 2 continues on the next page

0 2 . 2 **Figure 3** shows how the speed of the car affects the minimum braking distance of the car.

Figure 3



Describe the relationship between the speed of the car and the minimum braking distance of the car.

[1 mark]

0 2 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

When the road becomes icy, the braking distance _____ .

4.5.6.3.2 Reaction time

Question 12 · continued

A car driver applies the brakes to decelerate the car as it approaches a road junction.

The car decelerates at 0.25 m/s^2.

mass of the car = 1600 kg

0 2 . 4 Calculate the time taken for the velocity of the car to decrease from 12.5 m/s to 5.0 m/s.

Use the equation:

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

[3 marks]

Time taken = _____ s

0 2 . 5 Calculate the resultant force causing the car to decelerate.

Use the equation:

$$\text{resultant force} = \text{mass} \times \text{deceleration}$$

[2 marks]

Resultant force = _____ N

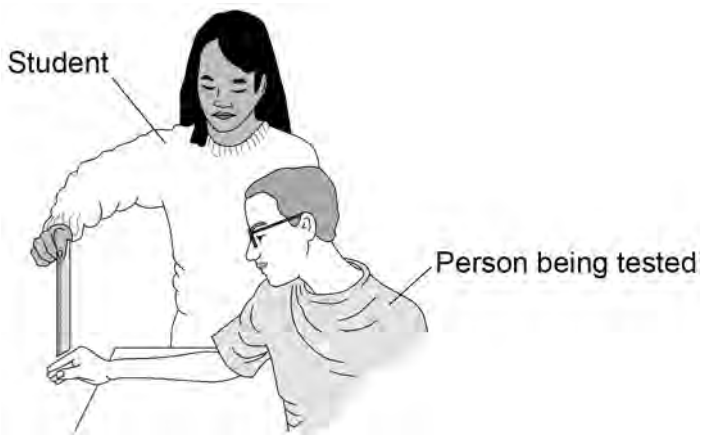
4.5.6.3.2 Reaction time

Question 12 · continued

Thinking distance is affected by the reaction time of the driver.

Figure 4 shows how a student tested a person's reaction time.

Figure 4



The student held a ruler and then released it.

The person being tested closed his hand to catch the ruler as quickly as possible.

The further the ruler fell the greater the person's reaction time.

0 2 . 6 The student wanted to test the reaction time of the people in her class.

Which of the following could have been a control variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Distance fallen by the ruler before being caught ☐

Initial height of the ruler above the person's hand ☐

Reaction time of the person being tested ☐

4.5.6.3.2 Reaction time

Question 12 · continued

0 2 . 7 The student tested three people in her class.

The mean distance that the ruler fell before being caught was 18.2 cm.

If all of the people in her class were tested, the mean distance may not be 18.2 cm.

Suggest why.

[1 mark]

0 2 . 8 Describe how this investigation could be changed to find out how listening to music affects reaction time.

[2 marks]

13

4.5.6.3.2 Reaction time

Question 13

0 4 Car **X** and car **Y** have engines that produce the same maximum forward force.

The cars are the same shape, but car **X** has a greater mass than car **Y**.

0 4 . 1 How does the maximum acceleration of car **X** and car **Y** compare?

[1 mark]

Tick (✓) **one** box.

Car **X** has a greater maximum acceleration. ☐

Car **X** and car **Y** have the same maximum acceleration. ☐

Car **X** has a smaller maximum acceleration. ☐

0 4 . 2 Car **Y** has a mass of 900 kg.

Car **Y** accelerates at 2.5 m/s^2.

Calculate the resultant force on car **Y**.

Use the equation:

resultant force = mass × acceleration

[2 marks]

Resultant force = _____ N

Question 4 continues on the next page

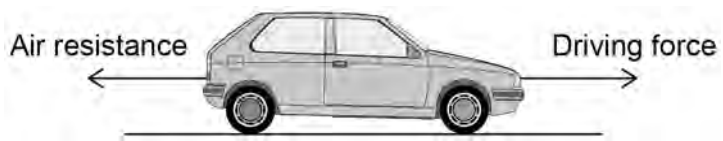
4.5.6.3.2 Reaction time

Question 13 · continued

0 4 . 3 A car moves at a constant speed on a level road.

Figure 4 shows the horizontal forces on the car.

Figure 4



The driver makes the car accelerate until the car reaches its maximum speed.

Explain how the horizontal forces on the car change as the car accelerates to its maximum speed.

[4 marks]

4.5.6.3.2 Reaction time

Question 13 · continued

To pass a driving test, drivers need to understand the difference between thinking distance and braking distance.

0 4 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

force	length	time

The thinking distance is affected by the driver's reaction _____.

0 4 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

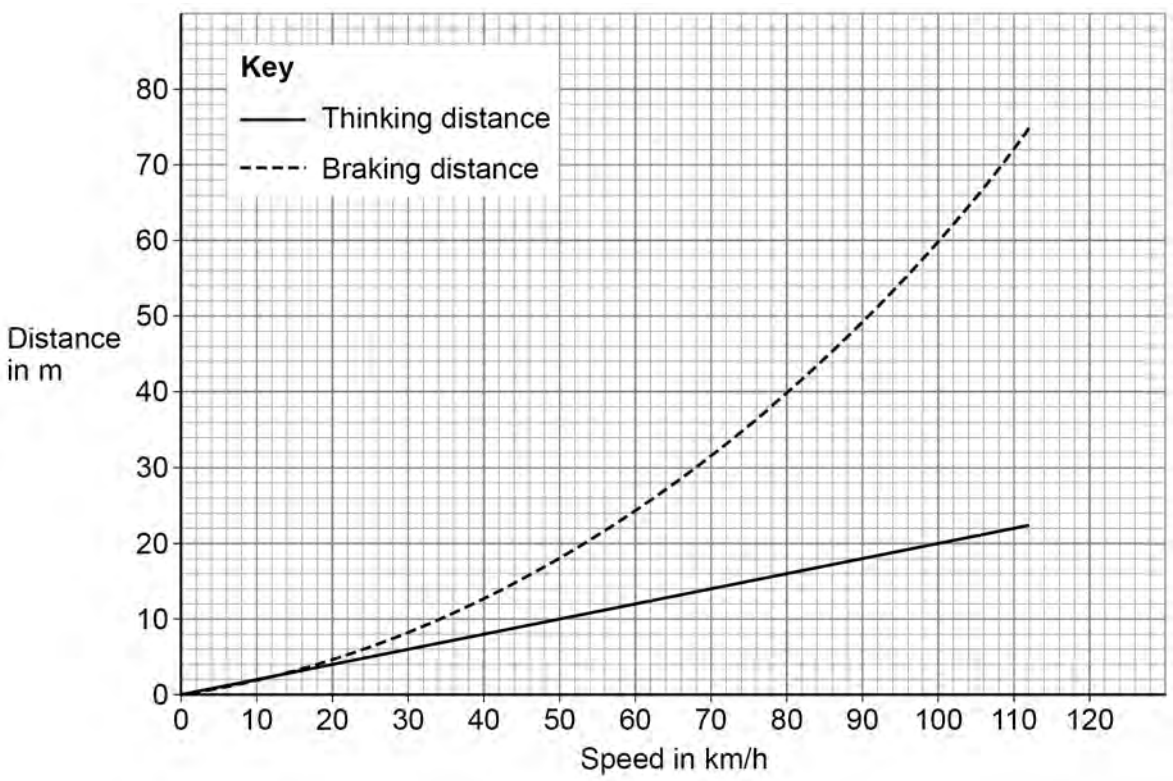
force	length	time

The braking distance is the distance travelled by the car under the braking _____.

Question 4 continues on the next page

0 4 . 6 **Figure 5** shows how speed affects the thinking distance and braking distance of a car.

Figure 5



The car is moving at a speed of 100 km/h.

Calculate the stopping distance of the car.

Use **Figure 5**.

[3 marks]

Stopping distance = _____ m

4.5.6.3.2 Reaction time

Question 13 · continued

0 4 . 7 Which **two** of the following would **increase** the stopping distance of a car?

[2 marks]

Tick (✓) **two** boxes.

- Fitting new brakes to the car ☐
- Fitting new tyres to the car ☐
- The driver becoming tired ☐
- Driving uphill ☐
- Driving on a wet road ☐

14

Turn over for the next question