AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.7.3

Changes in momentum (physics only)

Past-paper questions

Tier	**Higher**
Question groups	**14**
Available paper years	**2003–2023**

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:** _____

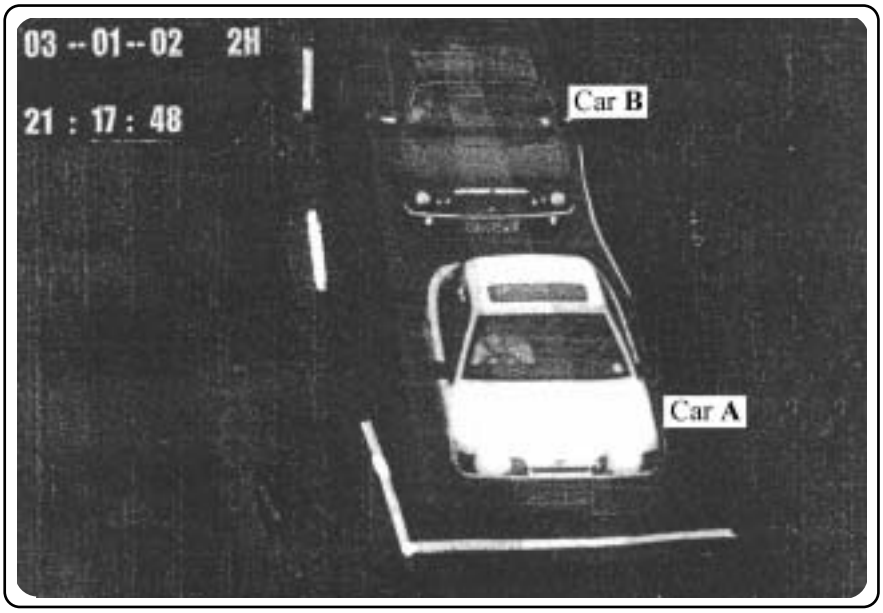
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.7.3 Changes in momentum (physics only)

Question 01

June 2003 | 3451H | Original Q16 | Legacy

16 The roads were very icy. An accident was recorded by a security camera.



Car **A** was waiting at a road junction. Car **B**, travelling at 10 m/s, went into the back of car **A**. This reduced car **B**'s speed to 4 m/s and caused car **A** to move forward.

The total mass of car **A** was 1200 kg and the total mass of car **B** was 1500 kg.

(a) (i) Write down the equation, in words, which you need to use to calculate momentum.

.....

(1 mark)

(ii) Calculate the change in momentum of car **B** in this accident.

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

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Change in momentum = ...

(3 marks)

(iii) Use your knowledge of the conservation of momentum to calculate the speed, in m/s, of car **A** when it was moved forward in this accident.

Show clearly how you work out your final answer.

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Speed = ...m/s

(3 marks)

4.5.7.3 Changes in momentum (physics only)

Question 01 · continued

MARGIN
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(b)



Brian and Susan are talking about the use of security cameras. Brian thinks there are advantages to having them but Susan thinks there are disadvantages.

Apart from the cost of installing and monitoring security cameras, and apart from the use of security cameras in recording traffic accidents, give the reasons which Brian and Susan may have for their views.

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(5 marks)

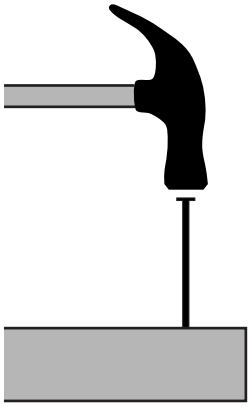
12

4.5.7.3 Changes in momentum (physics only)

Question 02

June 2004 | 3451H | Original Q16 | Legacy

16 (a) The diagram shows a hammer which is just about to drive a nail into a block of wood.



The mass of the hammer is 0.75 kg and its velocity, just before it hits the nail, is 15.0 m/s downward. After hitting the nail, the hammer remains in contact with it for 0.1 s. After this time both the hammer and the nail have stopped moving.

(i) Write down the equation, in words, which you need to use to calculate momentum.

.....

(1 mark)

(ii) What is the momentum of the hammer just before it hits the nail?

Show how you work out your answer and give the units and direction.

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Momentum = ...

(3 marks)

(iii) What is the change in momentum of the hammer during the time it is in contact with the nail?

.....

(1 mark)

4.5.7.3 Changes in momentum (physics only)

Question 02 · continued

MARGIN BLANK

(iv) Write down an equation which connects *change in momentum*, *force* and *time*.

.....

(1 mark)

(v) Calculate the force applied by the hammer to the nail.

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

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Force =.....

(3 marks)

(b) A magazine article states that:

"Wearing a seat belt can save your life in a car crash."

Use your understanding of momentum to explain how this is correct.

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(4 marks)

13

4.5.7.3 Changes in momentum (physics only)

Question 03

June 2005 | 3451 | Original Q14 | Legacy

14 (a) When two objects collide, and no other forces act, then *conservation of momentum* applies.

(i) What does the term *conservation of momentum* mean?

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(2 marks)

(ii) Apart from collisions and similar events, give another type of event in which *conservation of momentum* applies.

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(1 mark)

(iii) Write, in words, the equation which you need to use to calculate momentum.

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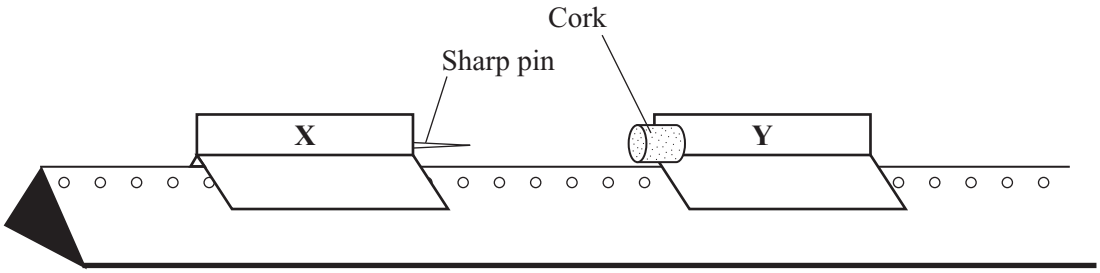
(1 mark)

(iv) The diagram shows a straight and horizontal runway and two trolleys, **X** and **Y**, which can move on the runway.



X has a mass of 0.2 kg and its velocity is 1.2 m/s to the right. **Y** has a mass of 0.1 kg and is stationary. When **X** collides with **Y** they stick together.

Calculate the velocity of the trolleys after the collision.

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

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Velocity of the trolleys = ...

(5 marks)

4.5.7.3 Changes in momentum (physics only)

Question 03 · continued

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(v) What assumption did you make in order to calculate your answer to part (a)(iv)?

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.....

(1 mark)

(b) Just before it hits a target, a bullet has a momentum of 5 kg m/s. It takes 0.00125 s for the target to stop the bullet.

Calculate the force, in newtons, needed to do this.

Write, in words, the equation that you will need to use and show clearly how you work out your answer.

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Force = ... newtons

(3 marks)

13

TURN OVER FOR THE NEXT QUESTION

4.5.7.3 Changes in momentum (physics only)

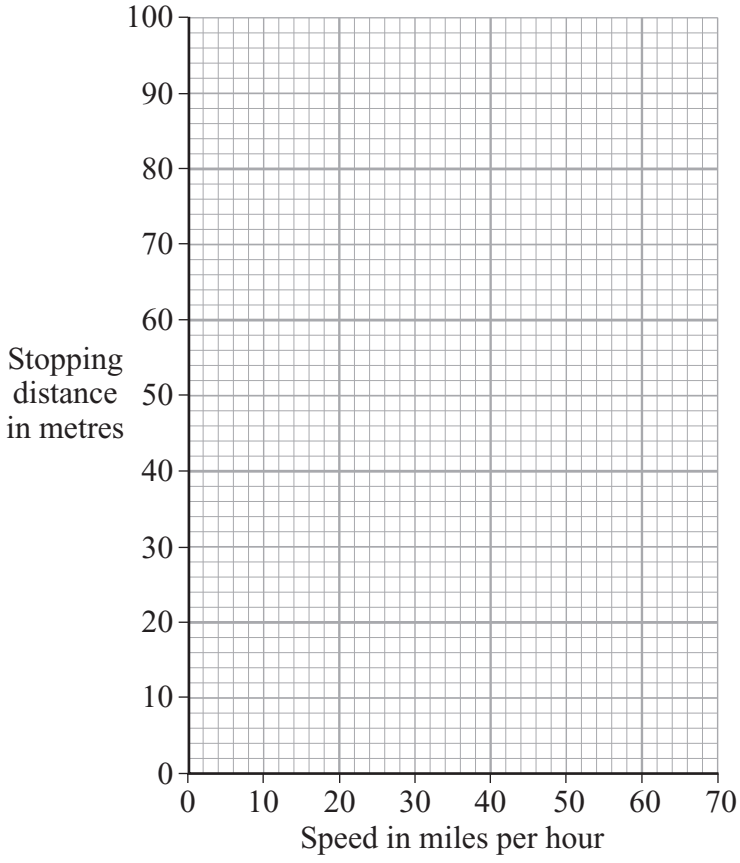
Question 04

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.

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(2 marks)

Question 4 continues on the next page

4.5.7.3 Changes in momentum (physics only)

Question 04 · continued

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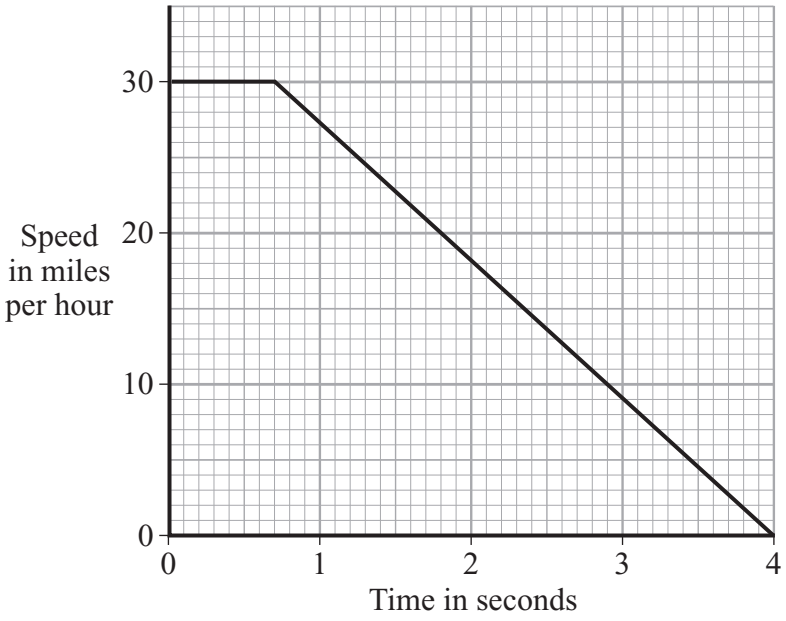
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(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.

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(2 marks)

4.5.7.3 Changes in momentum (physics only)

Question 04 · continued

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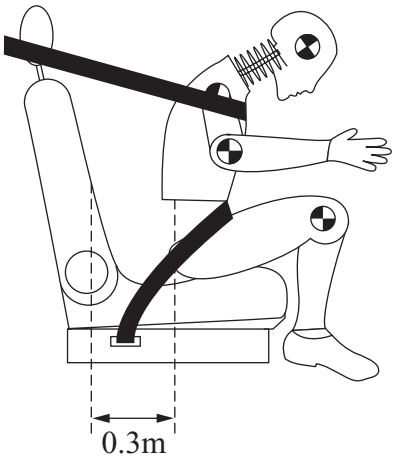
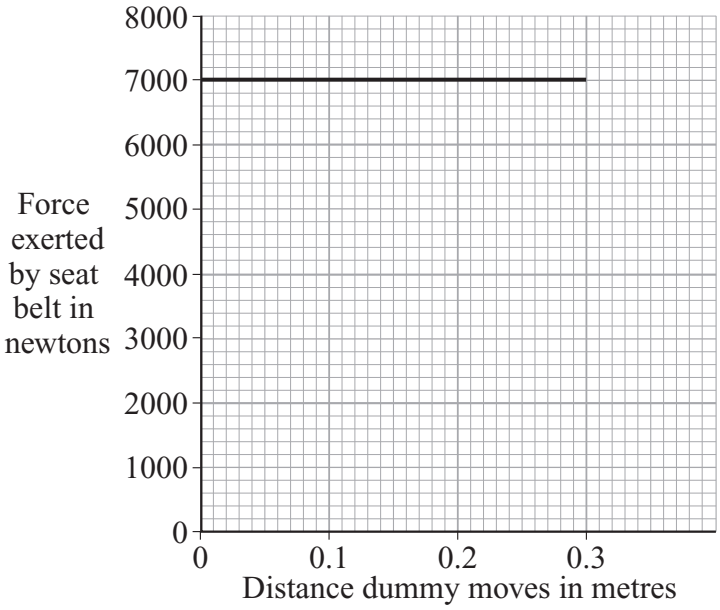
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(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.

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.....

Work done = ... joules

(2 marks)

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

.....

(1 mark)

14

4.5.7.3 Changes in momentum (physics only)

Question 05

June 2006 | 3451 | Original Q17 | Legacy

17 (a) A golf ball is driven forward when it is hit with a golf club.



(i) Write down the equation that connects change in momentum, force and time.

.....

(1 mark)

(ii) Calculate the change in momentum of a golf club which exerts an average force on a golf ball of 45 N for 0.9 seconds.

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

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Change in momentum = ...

(3 marks)

Question 05 · continued

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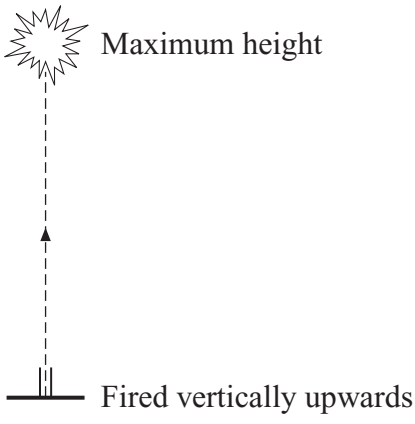
A firework fires a small explosive package into the air. The mass of the package is 50 g. When the package is at its maximum height it explodes.



(b) Just after take off, the momentum of the package is 1.5 kg m/s vertically upwards.

What is the velocity of the package?

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

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Velocity, vertically upwards = ...

(5 marks)

(c) At the moment when it reaches its maximum height the velocity of the package is zero. At the same moment the package explodes into a cloud of dust and gas.

(i) What is the total momentum of this 'cloud' immediately after the explosion?

.....

(1 mark)

(ii) What assumption did you make in order to give your answer to part (c)(i)?

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(1 mark)

(iii) What will be the direction of the total momentum of the 'cloud' a few seconds after the explosion?

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(1 mark)

12

4.5.7.3 Changes in momentum (physics only)

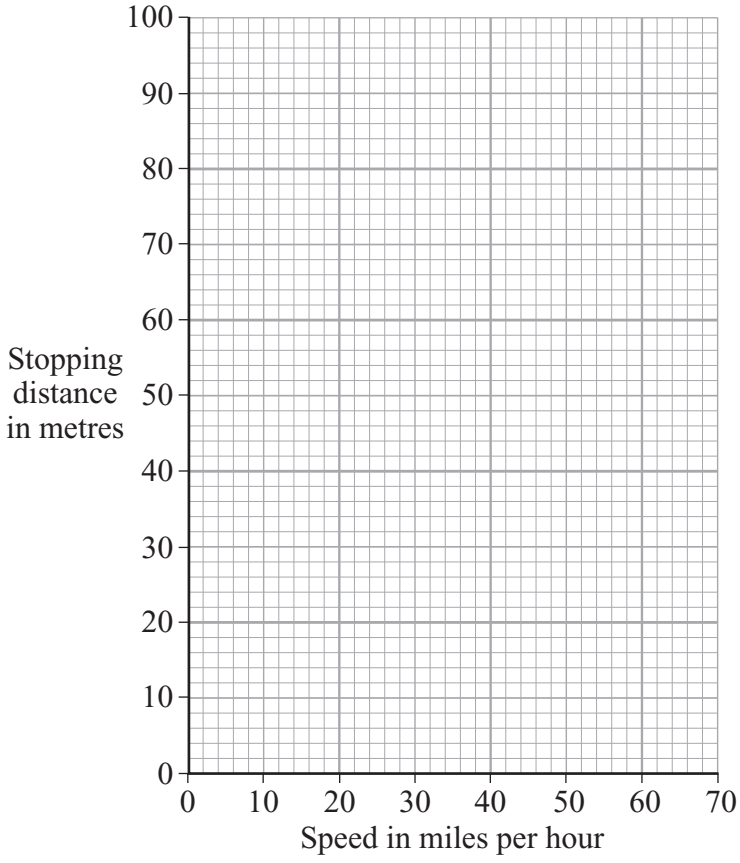
Question 06

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

Question 06 · continued

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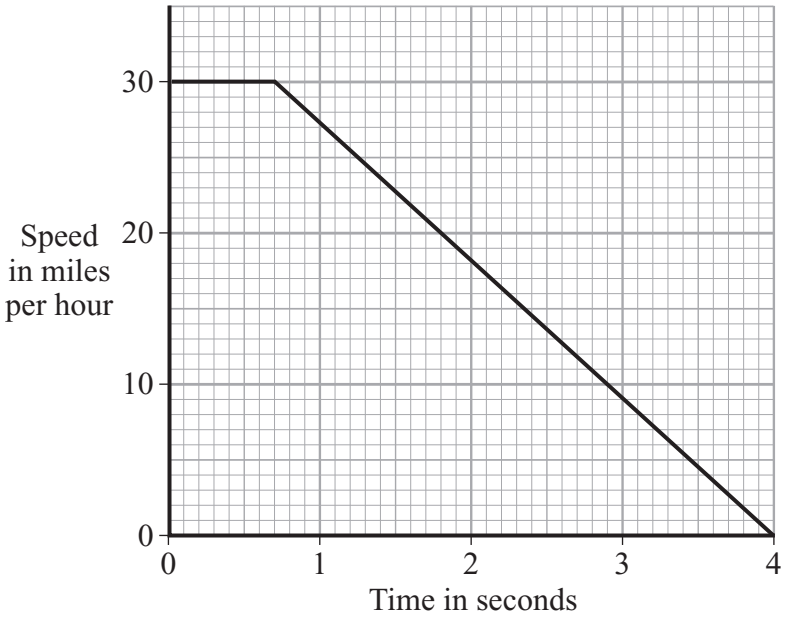
(b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



(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.

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(2 marks)

4.5.7.3 Changes in momentum (physics only)

Question 06 · continued

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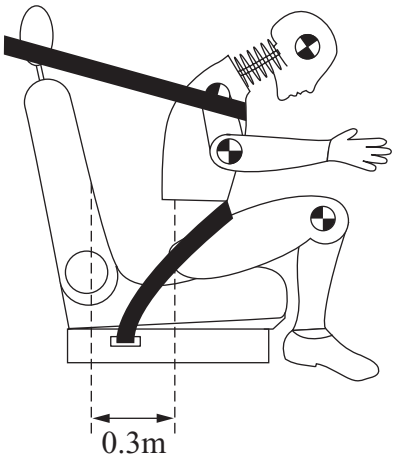
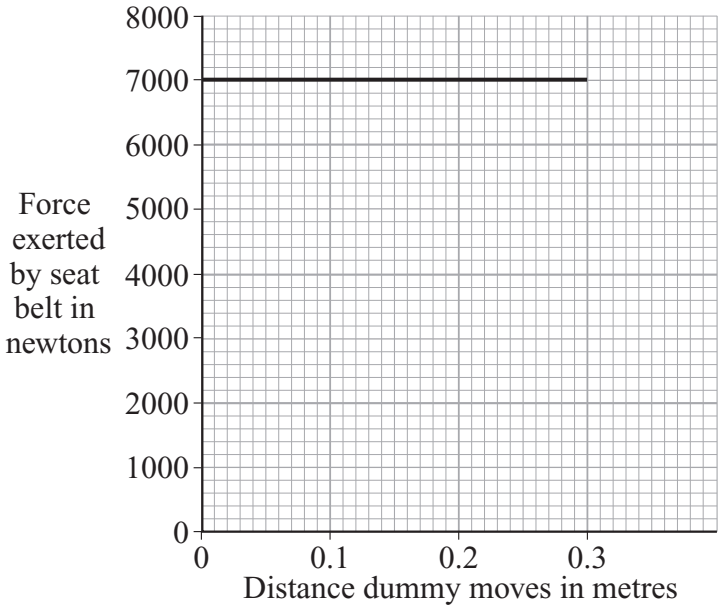
(c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.





(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

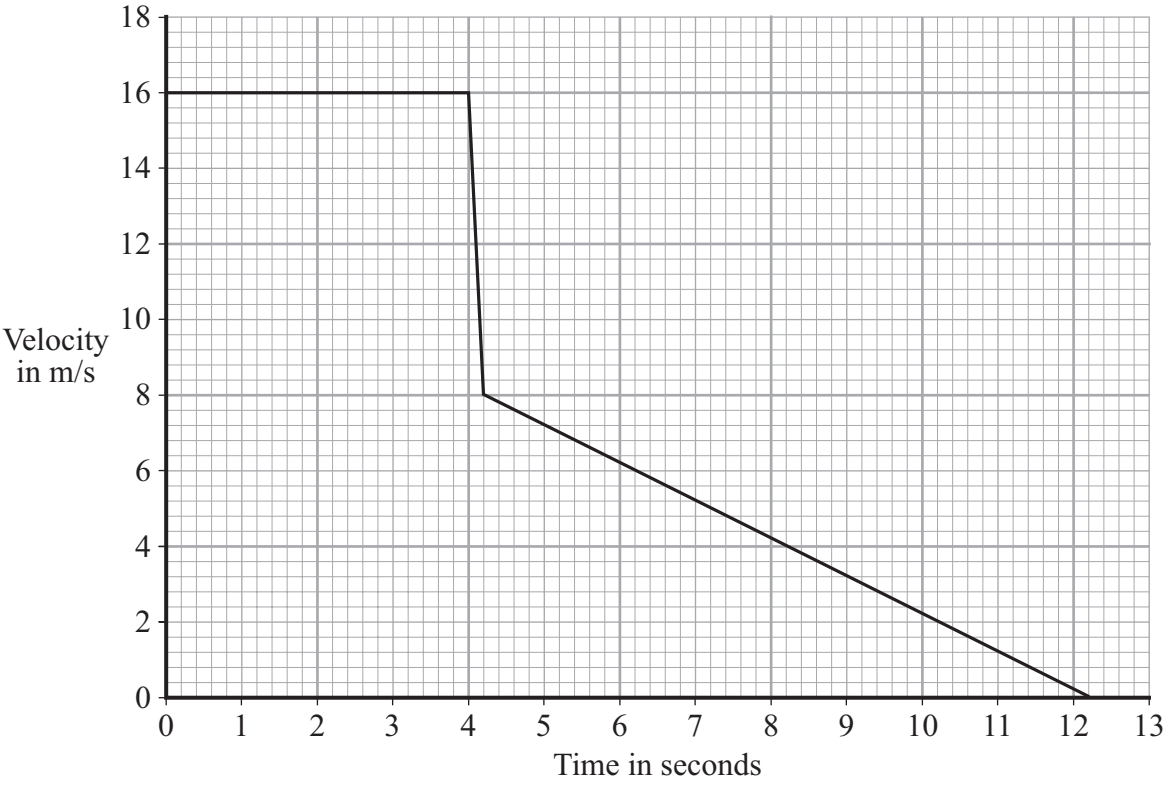
4.5.7.3 Changes in momentum (physics only)

Question 07

January 2008 | PHY2H | Original Q6 | Legacy

6 In an experiment at an accident research laboratory, a car driven by remote control was crashed into the back of an identical stationary car. On impact the two cars joined together and moved in a straight line.

(a) The graph shows how the *velocity* of the remote-controlled car changed during the experiment.



(i) How is the *velocity* of a car different from the speed of a car?

.....

(1 mark)

(ii) Use the graph to calculate the distance travelled by the remote-controlled car before the collision.

Show clearly how you work out your answer.

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Distance = ... m

(2 marks)

4.5.7.3 Changes in momentum (physics only)

Question 07 · continued

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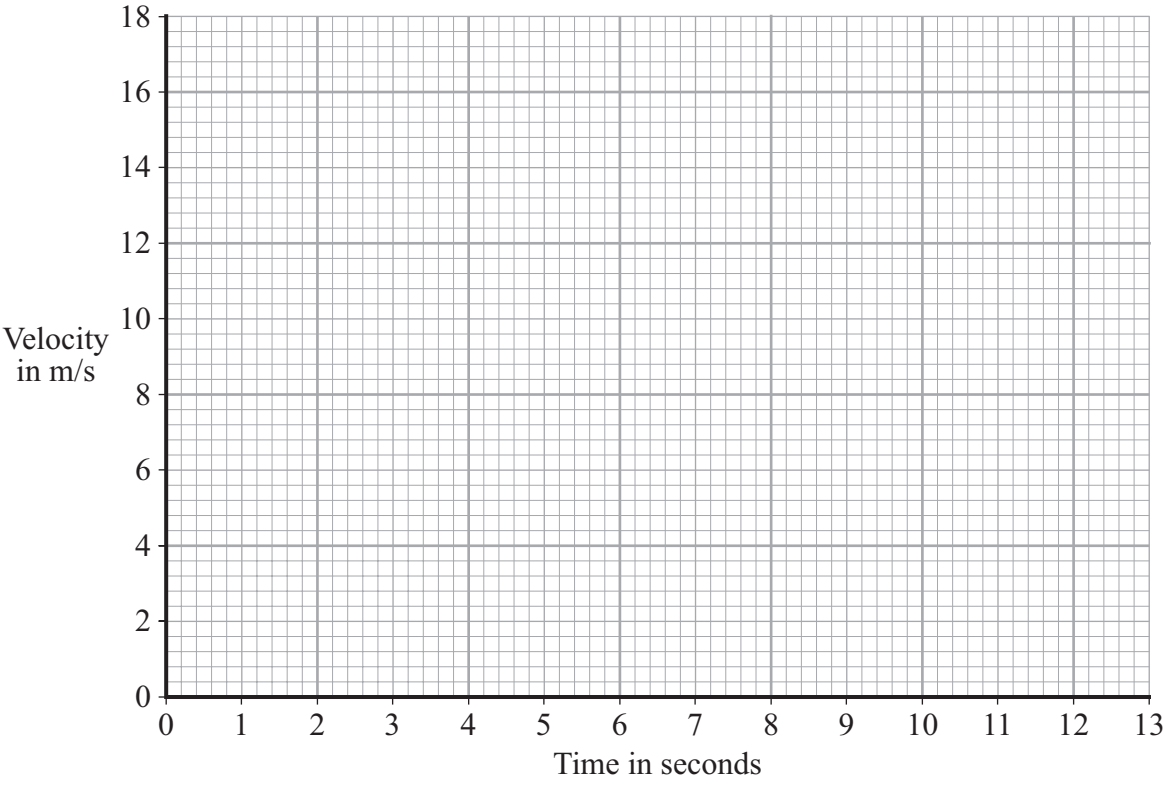
(iii) Draw, on the grid below, a graph to show how the velocity of the second car changed during the experiment.



(2 marks)

(iv) The total momentum of the two cars was not conserved.

What does this statement mean?

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(1 mark)

Question 6 continues on the next page

4.5.7.3 Changes in momentum (physics only)

Question 07 · continued

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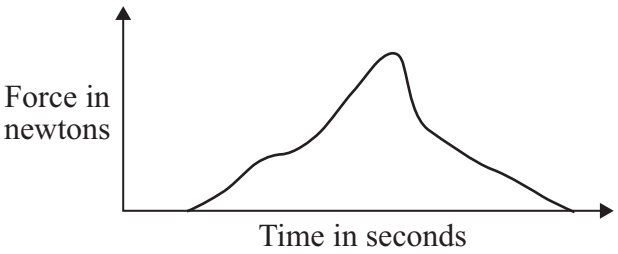
(b) The graph line shows how the force from a seat belt on a car driver changes during a collision.



Scientists at the accident research laboratory want to develop a seat belt that produces a constant force throughout a collision.

Use the idea of momentum to explain why this type of seat belt would be better for a car driver.

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(2 marks)

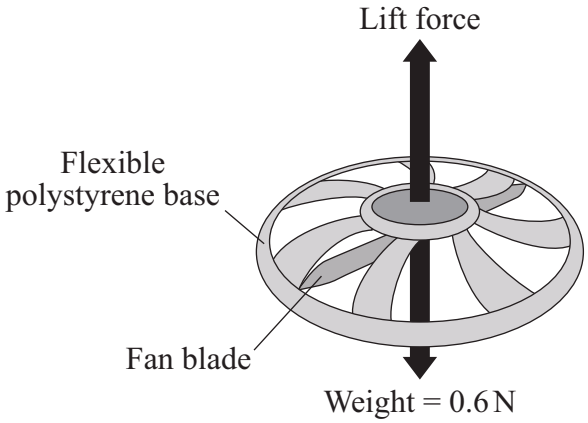
8

4.5.7.3 Changes in momentum (physics only)

Question 08

June 2008 | PHY2H | Original Q7 | Legacy

7 The diagram shows a small, radio-controlled, flying toy. A fan inside the toy pushes air downwards creating the lift force on the toy.



When the toy is hovering in mid-air, the fan is pushing 1.5 kg of air downwards every 10 seconds. Before the toy is switched on, the air is stationary.

7 (a) Use the equations in the box to calculate the velocity of the air when the toy is hovering.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for the change}}$$

Show clearly how you work out your answer.

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.....

Velocity = ... m/s

(3 marks)

Question 7 continues on the next page

4.5.7.3 Changes in momentum (physics only)

Question 08 · continued

for mark

7 (b) Explain why the toy accelerates upwards when the fan rotates faster.

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(2 marks)

7 (c) The toy is not easy to control so it often falls to the ground.

Explain how the flexible polystyrene base helps to protect the toy from being damaged when it crashes into the ground.

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(3 marks)

8

4.5.7.3 Changes in momentum (physics only)

Question 09

June 2009 | PHY2H | Original Q4 | Legacy

4 The diagram shows a child on a playground swing.
The playground has a rubber safety surface.



4 (a) The child, with a mass of 35 kg, falls off the swing and hits the ground at a speed of 6 m/s.

4 (a) (i) Use the equation in the box to calculate the momentum of the child as it hits the ground.

momentum = mass × velocity

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

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Momentum = ...

(3 marks)

4.5.7.3 Changes in momentum (physics only)

Question 09 · continued

for mark

4 (a) (ii) After hitting the ground, the child slows down and stops in 0.25 s.
Use the equation in the box to calculate the force exerted by the ground on the child.

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for the change}}$$

Show clearly how you work out your answer.

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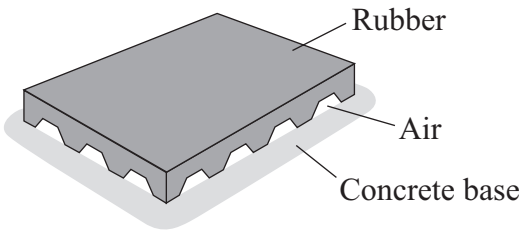
Force = ... N

(2 marks)

4 (b) The diagram shows the type of rubber tile used to cover the playground surface.



Explain how the rubber tiles reduce the risk of children being seriously injured when they fall off the playground equipment.

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(3 marks)

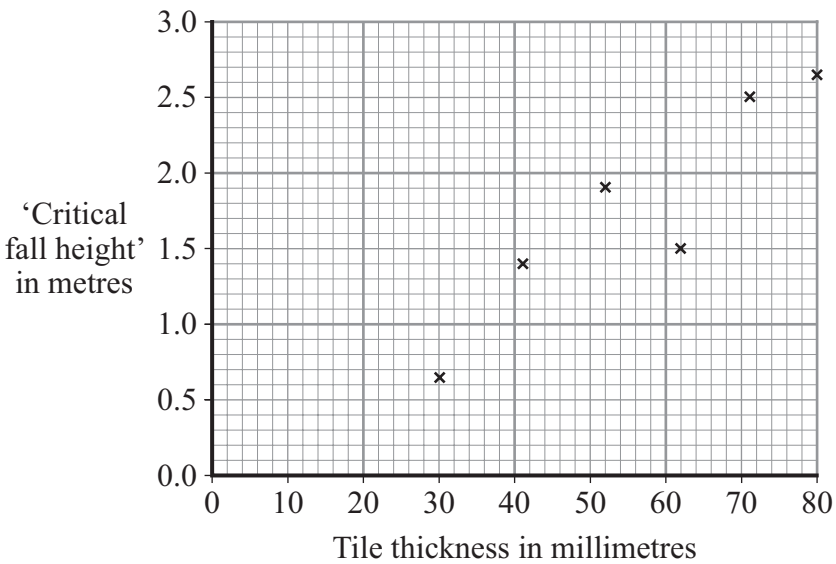
Question 4 continues on the next page

Question 09 · continued

for mark

4 (c) The 'critical fall height' is the height that a child can fall and **not** be expected to sustain a life-threatening head injury.
A new type of tile, made in a range of different thicknesses, was tested in a laboratory using test dummies and the 'critical fall height' measured. Only one test was completed on each tile.

The results are shown in the graph.



The 'critical fall height' for playground equipment varies from 0.5 m to 3.0 m.

Suggest **two** reasons why more tests are needed before this new type of tile can be used in a playground.

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(2 marks)

4 (d) Developments in technology allow manufacturers to make rubber tiles from scrap car tyres.

Suggest why this process may benefit the environment.

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(1 mark)

11

4.5.7.3 Changes in momentum (physics only)

Question 10

January 2011 | PHY2H | Original Q7 | Legacy

7 (a) Complete the following sentence.

The momentum of a moving object has a magnitude, in kg m/s,

and a ..... . *(1 mark)*

7 (b) A car being driven at 9.0 m/s collides with the back of a stationary lorry.
The car slows down and stops in 0.20 seconds. The total mass of the car and driver is 1200 kg.

Use the equations in the box to calculate the average force exerted by the lorry on the car during the collision.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time take for the change}}$$

Show clearly how you work out your answer.

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.....

Force = ... N
(2 marks)

7 (c) Within 0.04 s of the car hitting the back of the lorry, the car driver's airbag inflates.
The airbag deflates when it is hit by the driver's head.



Use the idea of momentum to explain why the airbag reduces the risk of the driver sustaining a serious head injury.

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(3 marks)

6

4.5.7.3 Changes in momentum (physics only)

Question 11

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]

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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]

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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]

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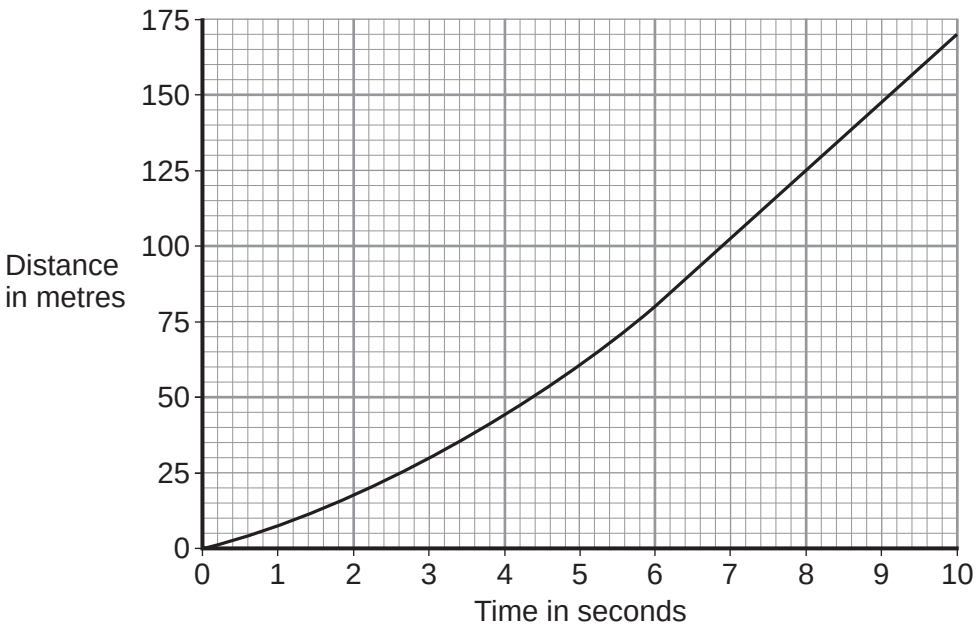
Question 4 continues on the next page

4.5.7.3 Changes in momentum (physics only)

Question 11 · continued

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]

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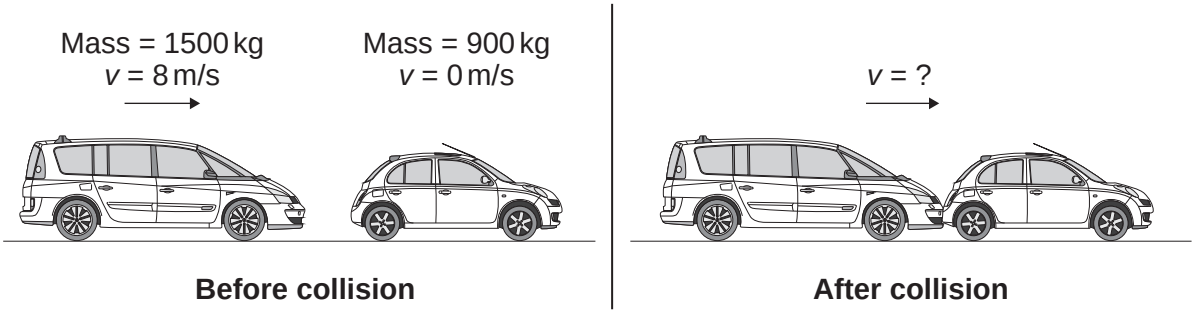
Maximum speed = ... m/s

Question 11 · 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]

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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

4.5.7.3 Changes in momentum (physics only)

Question 11 · 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

4.5.7.3 Changes in momentum (physics only)

Question 12

November 2020 | 8463/2H | Original Q5

0 5 **Figure 7** shows two ice hockey players moving towards each other.

They collide and then move off together.

Figure 7

Before the collision



Player A
Mass = 78 kg
Velocity = +7.5 m/s



Player B
Mass = 91 kg
Velocity = –5.5 m/s

During the collision, the total momentum of the players is conserved.

0 5 . 1 What is meant by 'momentum is conserved'?

[1 mark]

4.5.7.3 Changes in momentum (physics only)

Question 12 · continued

0 5 . 2 Immediately after the collision the two players move together to the right.

Calculate the velocity of the two players immediately after the collision.

[4 marks]

Velocity = _____ m/s

0 5 . 3 The ice hockey players wear protective pads filled with foam.

Explain how the protective pads help to reduce injury when the players collide.

[3 marks]

8

4.5.7.3 Changes in momentum (physics only)

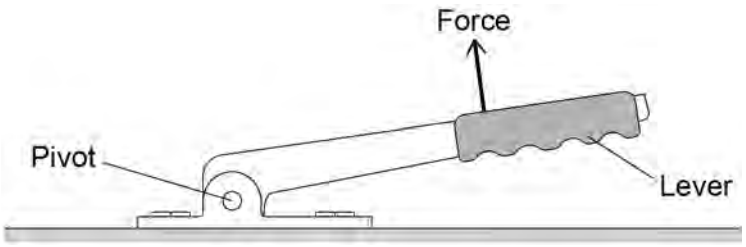
Question 13

June 2023 | 8463/2H | Original Q3

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]

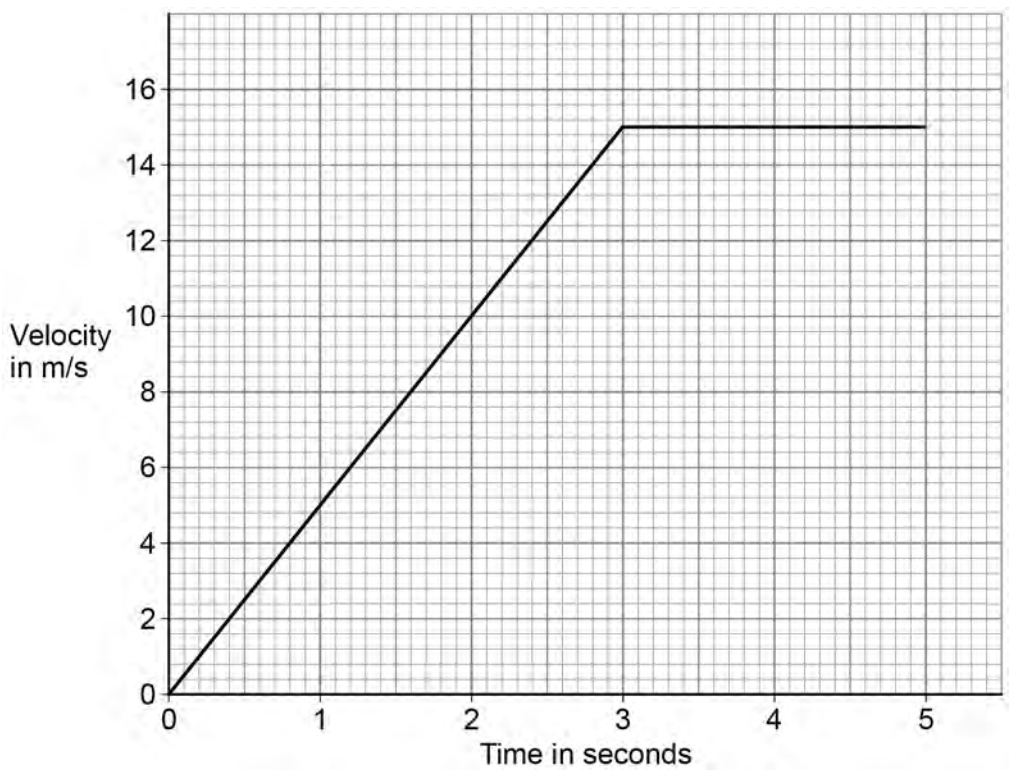
Question 3 continues on the next page

Question 13 · 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

4.5.7.3 Changes in momentum (physics only)

Question 13 · 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

4.5.7.3 Changes in momentum (physics only)

Question 13 · 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

4.5.7.3 Changes in momentum (physics only)

Question 14

June 2023 | 8463/2H | Original Q5

0 5 **Figure 14** shows some bumper cars.

Bumper cars are designed to withstand collisions at low speeds.

Figure 14



0 5 . 1 During a collision between a bumper car and the barrier, the bumper car and barrier act as a closed system.

What is meant by a 'closed system'?

[1 mark]

4.5.7.3 Changes in momentum (physics only)

Question 14 · continued

0 5 . 2 How does Newton's Third Law of motion apply to the collision between the bumper car and the barrier?

[1 mark]

0 5 . 3 During the collision, the change in momentum of the bumper car is 700 kg m/s.

The time taken for the collision is 0.28 s.

Calculate the force on the bumper car during the collision.

Use the Physics Equations Sheet.

[2 marks]

Force = _____ N

Question 5 continues on the next page

Question 14 · continued

0 5 . 4 The bumper car has a flexible bumper.

Explain how the flexible bumper reduces the risk of injury to the people in the bumper car during the collision.

[3 marks]

0 5 . 5 A bumper car moved with an initial constant velocity and then accelerated at 2.0 m/s^2.

While accelerating, the bumper car travelled a distance of 1.5 m.

The final velocity of the bumper car was 2.5 m/s.

Calculate the initial constant velocity of the bumper car.

Use the Physics Equations Sheet.

[3 marks]

Initial constant velocity = _____ m/s

10