AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.7.2

Conservation of momentum

Past-paper questions

Tier	**Higher**
Question groups	**12**
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:** _____

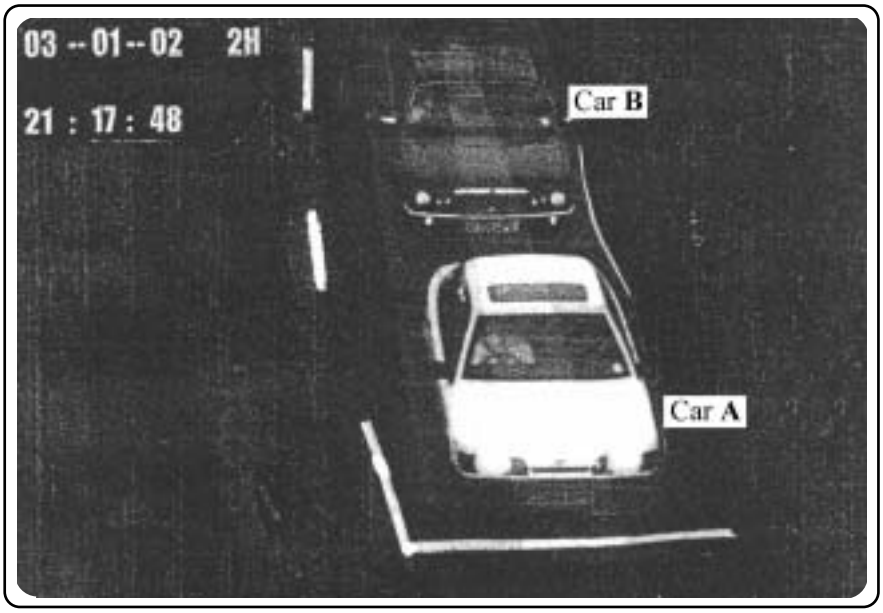
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.7.2 Conservation of momentum

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.

.....

.....

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.

.....

.....

Speed = ...m/s

(3 marks)

4.5.7.2 Conservation of momentum

Question 01 · continued

MARGIN BLANK

(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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

12

4.5.7.2 Conservation of momentum

Question 02

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?

.....

.....

.....

(2 marks)

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

.....

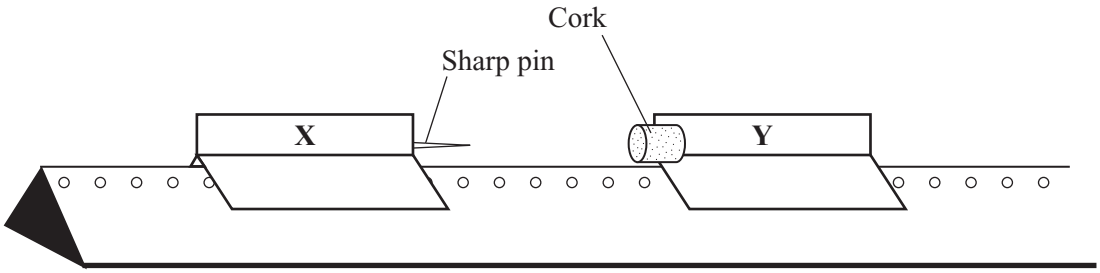
(1 mark)

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

.....

(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.

.....

.....

.....

.....

Velocity of the trolleys = ...

(5 marks)

4.5.7.2 Conservation of momentum

Question 02 · continued

MARGIN BLANK

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

.....

.....

(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.

.....

.....

.....

Force = ... newtons

(3 marks)

13

TURN OVER FOR THE NEXT QUESTION

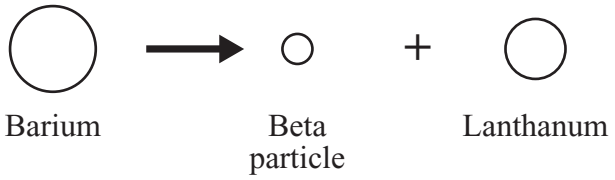
4.5.7.2 Conservation of momentum

Question 03

June 2006 | 3451 | Original Q10 | Legacy

10 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.

Not to scale



(i) What is a beta particle?

.....

(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

.....

.....

(1 mark)

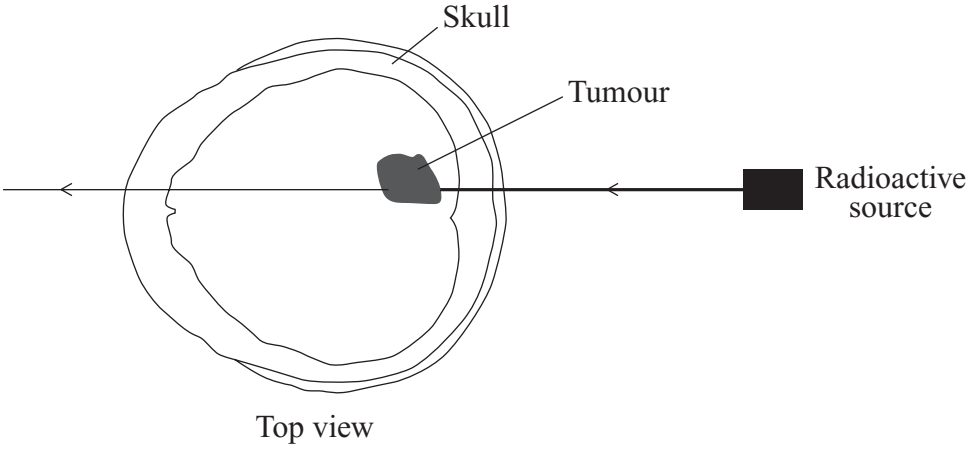
(iii) Describe how a neutral atom may be changed by a collision with a beta particle.

.....

.....

(1 mark)

(b) The diagram shows how radiation can be used to kill the cells of a brain tumour.



Why is a beta emitting radioactive source unsuitable for this purpose?

.....

.....

(1 mark)

4.5.7.2 Conservation of momentum

Question 03 · continued

BLANK

(c) The table gives the average radiation dose which someone in the UK receives in one year from background radiation.

Source of radiation	Dose in millisieverts
the ground	0.30
radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

.....

(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

.....

.....

.....

.....

(2 marks)

7

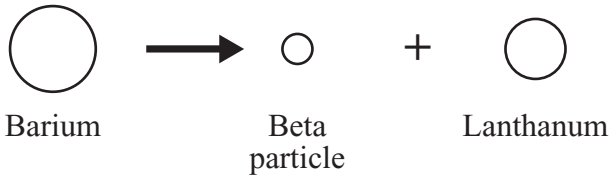
4.5.7.2 Conservation of momentum

Question 04

June 2006 | 3462 | Original Q8 | Legacy

8 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.

Not to scale



(i) What is a beta particle?

.....

(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

.....

.....

(1 mark)

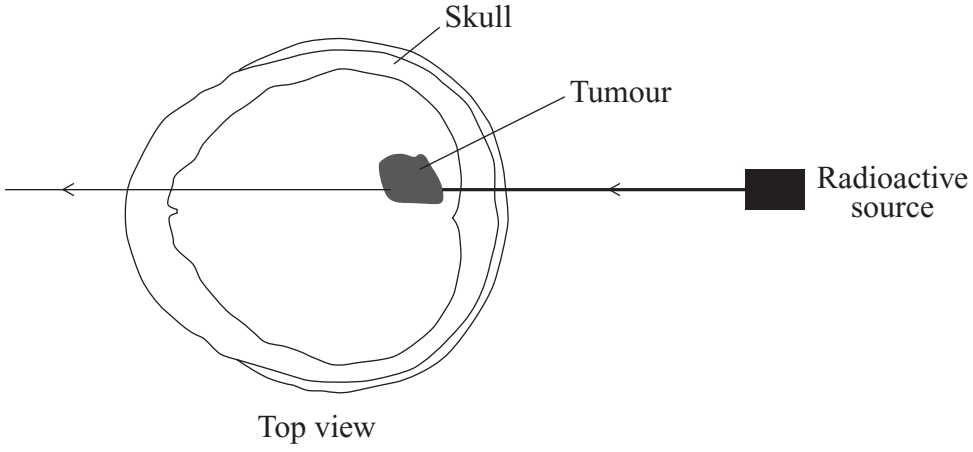
(iii) Describe how a neutral atom may be changed by a collision with a beta particle.

.....

.....

(1 mark)

(b) The diagram shows how radiation can be used to kill the cells of a brain tumour.



Top view

Why is a beta emitting radioactive source unsuitable for this purpose?

.....

.....

(1 mark)

4.5.7.2 Conservation of momentum

Question 04 · continued

BLANK

(c) The table gives the average radiation dose which someone in the UK receives in one year from background radiation.

Source of radiation	Dose in millisieverts
the ground	0.30
radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

.....

(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

.....

.....

.....

.....

(2 marks)

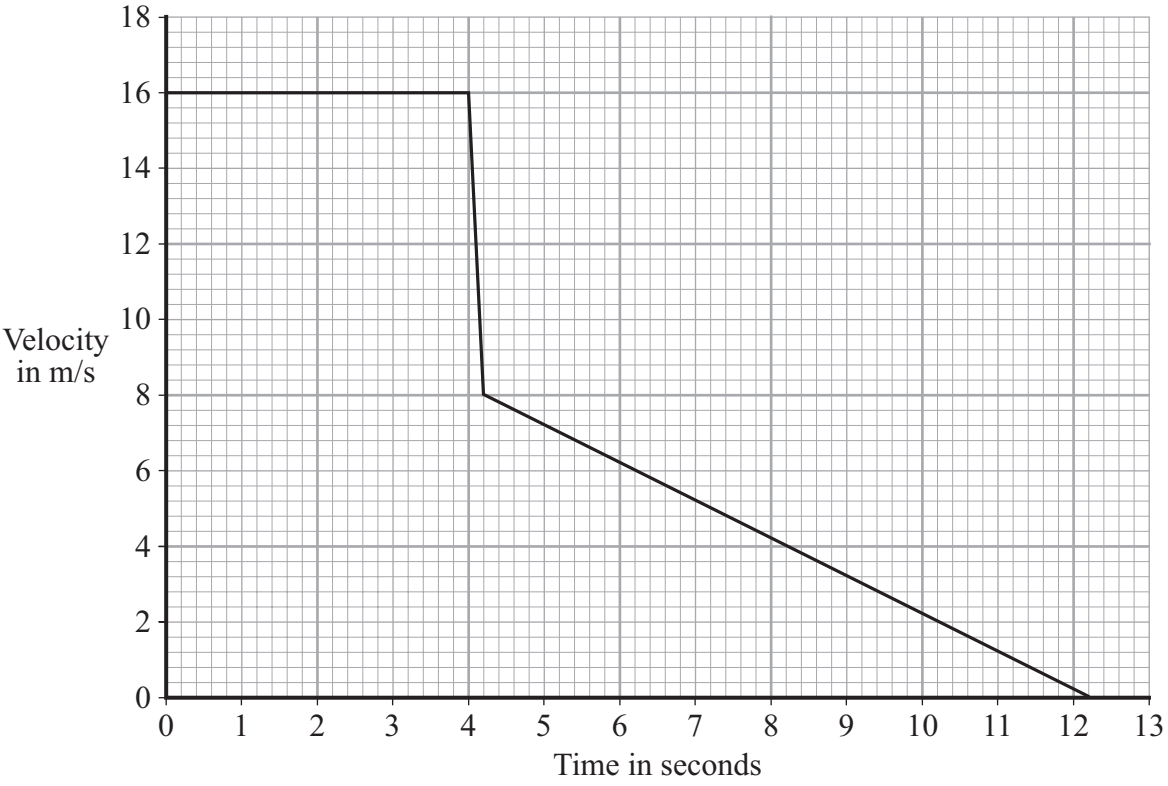
7

4.5.7.2 Conservation of momentum

Question 05

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.

.....

.....

Distance = ... m

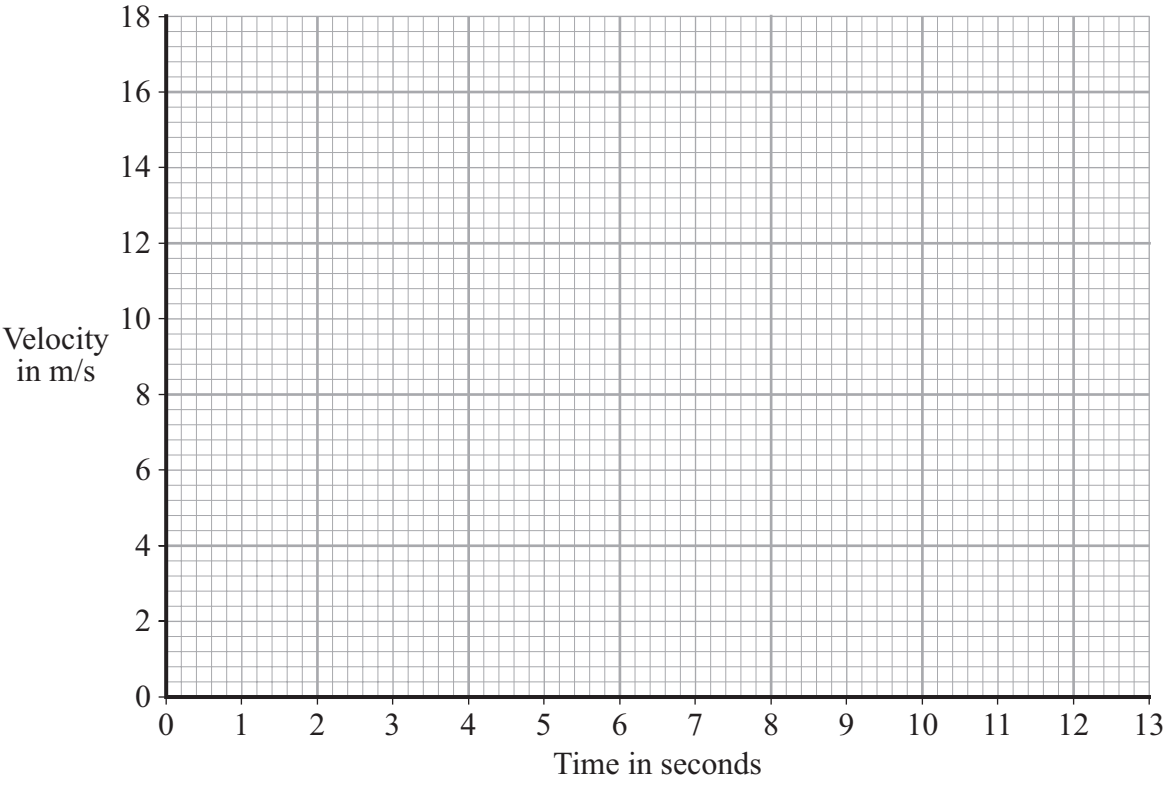
(2 marks)

4.5.7.2 Conservation of momentum

Question 05 · continued

BLANK

(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?

.....

.....

(1 mark)

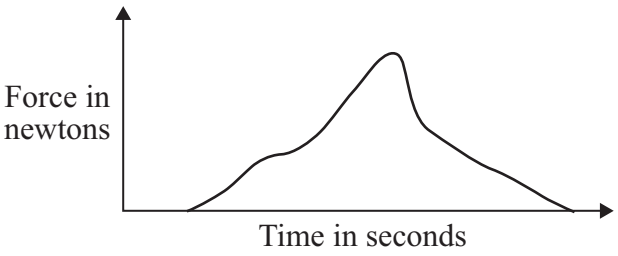
Question 6 continues on the next page

4.5.7.2 Conservation of momentum

Question 05 · continued

BLANK

(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.

.....

.....

.....

.....

(2 marks)

8

4.5.7.2 Conservation of momentum

Question 06

January 2010 | PHY2H | Original Q6 | Legacy

6 (a) In any collision, the total momentum of the colliding objects is usually conserved.

6 (a) (i) What is meant by the term 'momentum is conserved'?

.....

.....

(1 mark)

6 (a) (ii) In a collision, momentum is **not** always conserved.

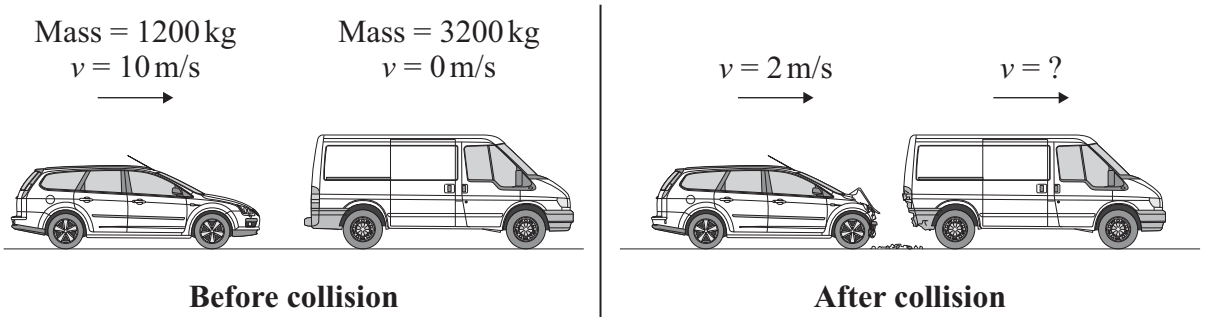
Why?

.....

.....

(1 mark)

6 (b) The diagram shows a car and a van, just before and just after the car collided with the van.



Before collision **After collision**

4.5.7.2 Conservation of momentum

Question 06 · continued

for mark

6 (b) (i) Use the information in the diagram and the equation in the box to calculate the **change** in the momentum of the car.

momentum = mass × velocity

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

.....

.....

.....

.....

Change in momentum = ...

(3 marks)

6 (b) (ii) Use the idea of conservation of momentum to calculate the velocity of the van when it is pushed forward by the collision.

Show clearly how you work out your answer.

.....

.....

.....

Velocity = ... m/s forward

(2 marks)

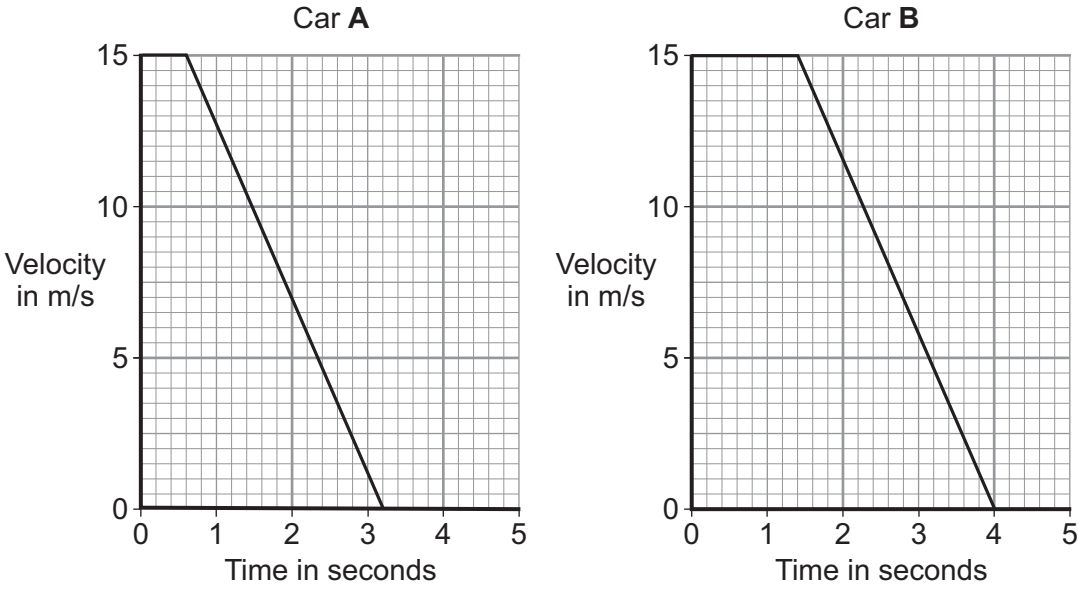
7

4.5.7.2 Conservation of momentum

Question 07

June 2010 | PHY2H | Original Q5 | Legacy

5 (a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

5 (a) (i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

.....

.....

(1 mark)

5 (a) (ii) How do the graphs show that the two cars have the same deceleration?

.....

.....

(1 mark)

5 (a) (iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

.....

.....

.....

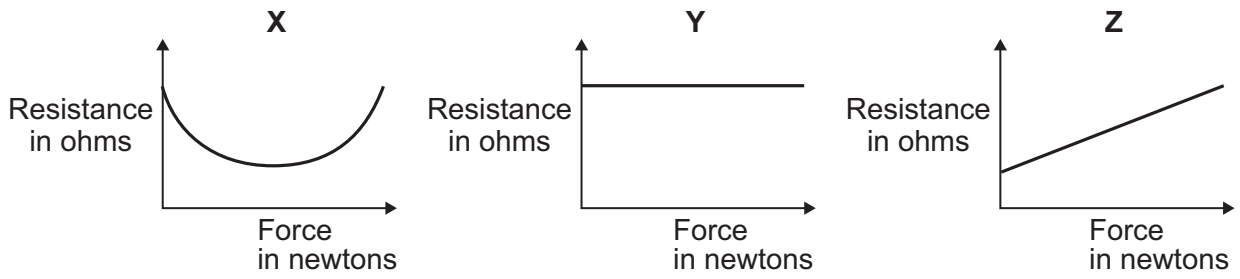
Additional stopping distance = ... m

(3 marks)

4.5.7.2 Conservation of momentum

Question 07 · continued

5 (b) In a crash test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y** and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

.....

Give a reason for your answer.

.....

.....

.....

.....

(2 marks)

7

4.5.7.2 Conservation of momentum

Question 08

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.

.....

.....

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.

.....

.....

.....

.....

.....

.....
(3 marks)

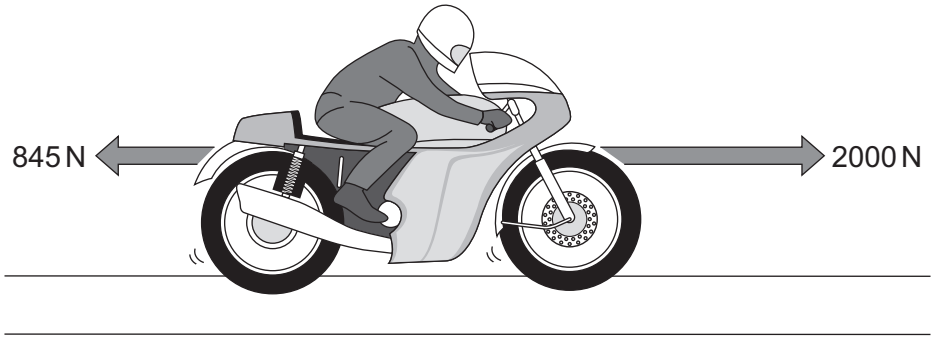
6

4.5.7.2 Conservation of momentum

Question 09

June 2011 | PHY2H | Original Q7 | Legacy

7 The arrows in the diagram represent the horizontal forces acting on a motorbike at one moment in time.



7 (a) The mass of the motorbike and rider is 275 kg.

Use the equation in the box to calculate the acceleration of the motorbike at this moment in time.

resultant force = mass × acceleration

Show clearly how you work out your answer.

.....

.....

.....

.....

.....

Acceleration = ... m/s ^{2}

(3 marks)

4.5.7.2 Conservation of momentum

Question 09 · continued

7 (b) A road safety organisation has investigated the causes of motorbike accidents.

The main aim of the investigation was to find out whether there was any evidence that young, inexperienced riders were more likely to be involved in an accident than older, experienced riders.

Data obtained by the organisation from a sample of 1800 police files involving motorbike accidents, is summarised in the table.

Size of motorbike engine	Percentage of all motorbikes sold	Total number in the sample of 1800 accident files
up to 125 cc	36	774
126 to 350 cc	7	126
351 to 500 cc	7	162
over 500 cc	50	738

Most of the motorbikes with engines up to 125 cc were ridden by young people. The motorbikes with engines over 500 cc were ridden by older, more experienced riders.

7 (b) (i) In terms of the main aim of the investigation, is this data valid?

Draw a ring around your answer. **NO** **YES**

Explain the reason for your answer.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

4.5.7.2 Conservation of momentum

Question 09 · continued

7 (b) (ii) The organisation concluded that:

"Young, inexperienced riders are more likely to be involved in a motorbike accident than older, experienced riders".

Explain how the data supports this conclusion.

.....

.....

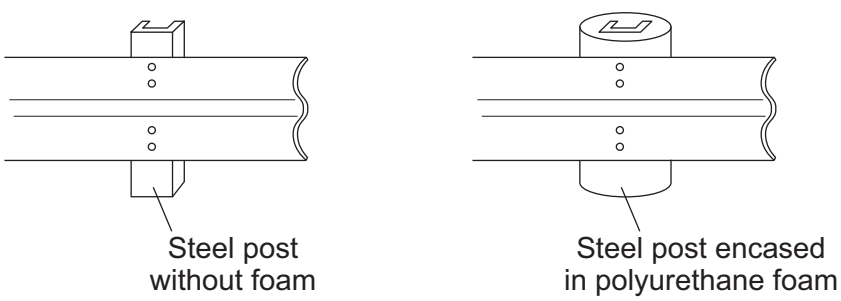
.....

.....

(2 marks)

7 (c) Of particular concern to motorbike riders is the design of steel crash barriers. Riders falling off and sliding at high speed into a steel support post are often seriously injured.

One way to reduce the risk of serious injury is to cover the post in a thick layer of high impact polyurethane foam.



7 (c) (i) Use the ideas of momentum to explain how the layer of foam reduces the risk of serious injury to a motorbike rider sliding at high speed into the support post.

.....

.....

.....

.....

.....

(3 marks)

4.5.7.2 Conservation of momentum

Question 09 · continued

7 (c) (ii) Crash barrier tests use dummies that collide at 17 m/s with the barrier. Each test costs about £12 000. New safety devices for crash barriers are tested many times to make sure that they will improve safety.

Do you think that the cost of developing the new safety devices is justified?

Draw a ring around your answer. **NO** **YES**

Give a reason for your answer.

.....

.....

(1 mark)

11

4.5.7.2 Conservation of momentum

Question 10

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]

.....

.....

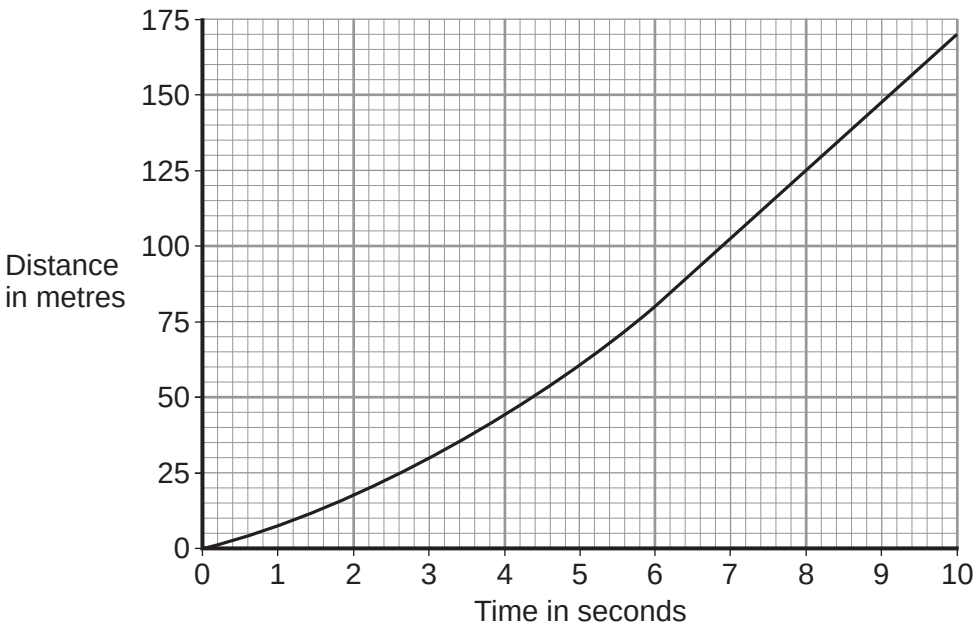
Question 4 continues on the next page

4.5.7.2 Conservation of momentum

Question 10 · 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]

.....

.....

Maximum speed = ... m/s

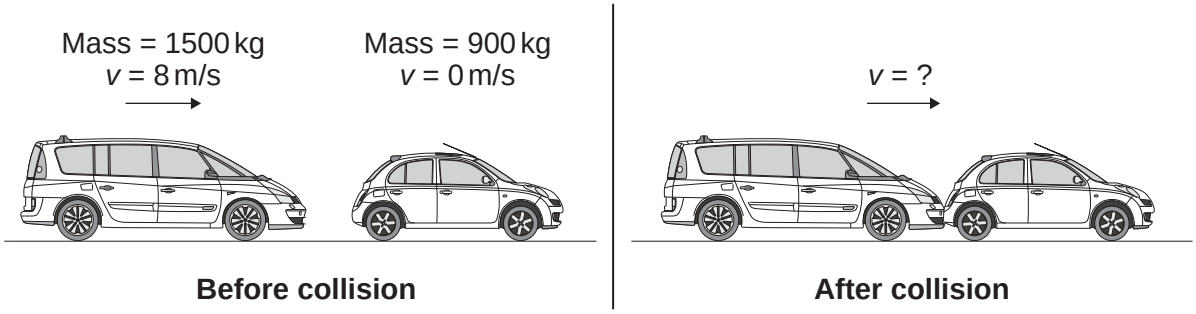
4.5.7.2 Conservation of momentum

Question 10 · 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

4.5.7.2 Conservation of momentum

Question 10 · 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

4.5.7.2 Conservation of momentum

Question 11

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]

4.5.7.2 Conservation of momentum

Question 11 · 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

4.5.7.2 Conservation of momentum

Question 12

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]

4.5.7.2 Conservation of momentum

Question 12 · 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

4.5.7.2 Conservation of momentum

Question 12 · 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