# Momentum

## Question Paper

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|---|---|
| Level | IGCSE |
| Subject | Physics (4403) |
| Exam Board | AQA |
| Unit | P2 |
| Topic | The Kinetic Energy of Objects Speeding Up or Slowing Down |
| Sub-Topic | Momentum |
| Booklet | Question Paper |

**Time Allowed:** **55 minutes**

**Score:** **/55**

**Percentage:** **/100**

**Grade Boundaries:**

**Q1.**Quantities in physics are either scalars or vectors.

(a) Use the correct answers from the box to complete the sentence.

| | | | | |
|---|---|---|---|---|
| **acceleration** | **direction** | **distance** | **speed** | **time** |

Velocity is ..... in a given ..... .

**(2)**

(b) Complete the table to show which quantities are scalars and which quantities are vectors.

Put **one** tick (✓) in each row.

The first row has been completed for you.

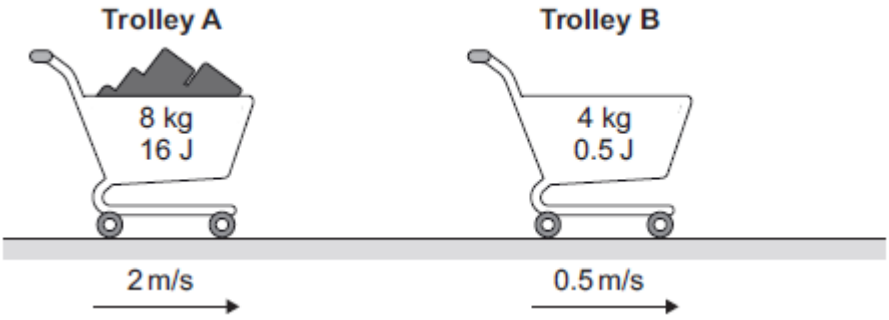
| Quantity | Scalar | Vector |
|---|---|---|
| Momentum | | ✓ |
| Acceleration | | |
| Distance | | |
| Force | | |
| Time | | |

**(3)**

(c) The diagram shows two supermarket trolleys moving in the same direction.

Trolley **A** is full of shopping, has a total mass of 8 kg and is moving at a velocity of 2 m / s with a kinetic energy of 16 J.

Trolley **B** is empty, has a mass of 4 kg and is moving at a velocity of 0.5 m / s with a kinetic energy of 0.5 J.




(i) Calculate the momentum of both trolley **A** and trolley **B**.

Give the unit.

Use the correct equation from the Physics Equations Sheet.

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Momentum of trolley **A** = .....

Momentum of trolley **B** = .....

Unit .....

**(4)**

(ii) The trolleys in the diagram collide and join together. They move off together.

Calculate the velocity with which they move off together.

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Velocity = ..... m / s

**(3)**

(iii) In a different situation, the trolleys in the digram move at the same speeds as before but now move towards each other.

Calculate the total momentum and the total kinetic energy of the two trolleys before they collide.

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Total momentum = .....

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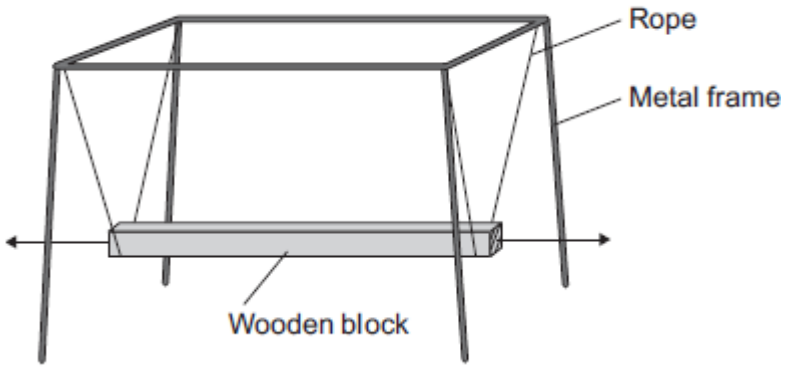
Total kinetic energy = ..... J

**(2)**
**(Total 14 marks)**

**Q2.Figure 1** shows the design of a playground ride.

**Figure 1**




A large wooden block rests on ropes. The ropes are attached to a metal frame.

Children sit on the wooden block.

When the wooden block is moved to the left and released it moves to and fro.

When the wooden block returns to the point of release it has completed one cycle.

(a) Identify **two** possible hazards of the ride in **Figure 1**.

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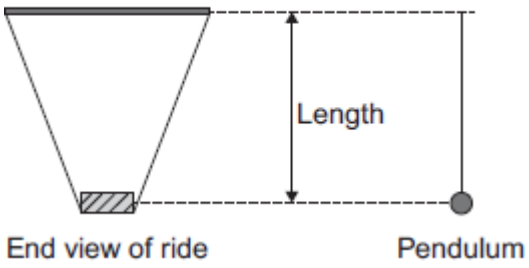
**(2)**

(b) The designer of the ride wants to know if the ride has the same time period as a pendulum of the same length.

The designer used a model of the ride and a pendulum as shown in **Figure 2**.

**Figure 2**




The designer measured the time taken to complete 10 cycles for different lengths of both the model ride and the pendulum.

The results for the model ride are shown in **Table 1**.

**Table 1**

| Length in metres | Time for 10 cycles in seconds | | | | Mean time period in seconds |
|---|---|---|---|---|---|
| | First time | Second time | Third time | Mean | |
| 0.100 | 6.36 | 6.37 | 6.29 | 6.34 | 0.63 |
| 0.150 | 7.76 | 7.74 | 7.80 | | |
| 0.200 | 8.97 | 8.99 | 8.95 | 8.97 | 0.90 |

The results for the pendulum are shown in **Table 2**.

**Table 2**

| Length in metres | Time for 10 cycles in seconds | | | | Mean time period in seconds |
|---|---|---|---|---|---|
| | First time | Second time | Third time | Mean | |
| 0.250 | 10.00 | 10.04 | 10.02 | 10.02 | 1.00 |
| 0.300 | 10.99 | 11.01 | 10.94 | 10.98 | 1.10 |
| 0.350 | 11.88 | 11.83 | 11.87 | 11.86 | 1.19 |

(i) Complete **Table 1**, giving values to an appropriate number of significant figures.

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**(3)**

(ii) The investigation already includes repeated readings.

Suggest **one** improvement that could be made to this investigation.

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**(1)**

(iii) The designer reads in an Advanced Physics textbook that:
'The square of the time period, *T*, for a simple pendulum is proportional to its length, $l$.'

$$T^2 \propto l$$

Would the model ride have the same time period as a simple pendulum of the same length?

Use **one** row of data from **Table 1** and **one** row of data from **Table 2** to work out your answer.

State your conclusion.

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**(3)**

(c) The ride was redesigned and built to make it safer.

The wood was moving at maximum speed. The maximum kinetic energy of the wood was 180 J.

A parent applied a force to the wood and stopped it in a distance of 0.25 m.

Calculate the force required.

Use the correct equation from the Physics Equations Sheet.

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Force = ..... N

**(3)**
**(Total 12 marks)**

**Q3.** An investigation was carried out to show how thinking distance, braking distance and stopping distance are affected by the speed of a car.

The results are shown in the table.

| Speed in metres per second | Thinking distance in metres | Braking distance in metres | Stopping distance in metres |
|---|---|---|---|
| 10 | 6 | 6 | 12 |
| 15 | 9 | 14 | 43 |
| 20 | 12 | 24 | 36 |
| 25 | 15 | 38 | 53 |
| 30 | 18 | 55 | 73 |

(a) Draw a ring around the correct answer to complete each sentence.

As speed increases, thinking distance

decreases.

increases.

stays the same.

As speed increases, braking distance

decreases.

increases.

stays the same.

**(2)**

(b) One of the values of stopping distance is incorrect.

Draw a ring around the incorrect value in the table.

Calculate the correct value of this stopping distance.

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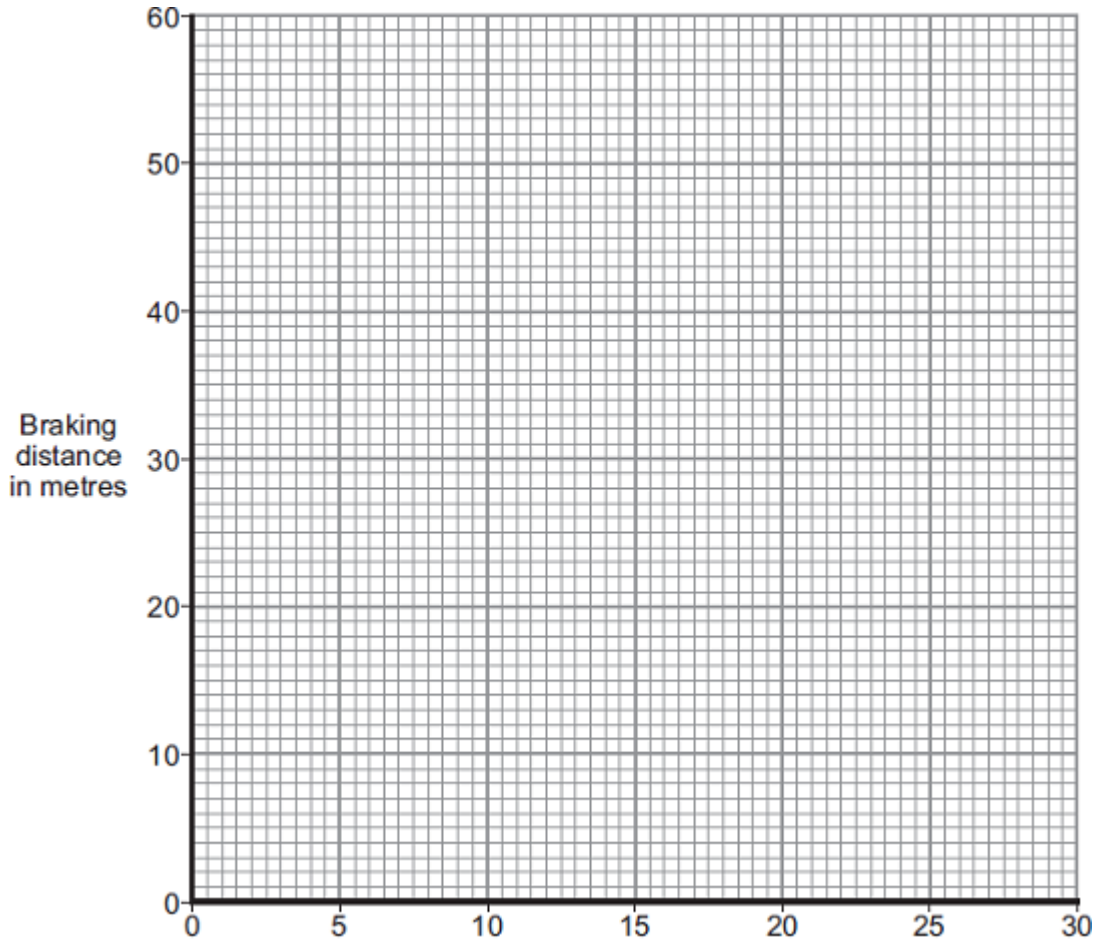
Stopping distance = ..... m

**(2)**

(c) (i) Using the results from the table, plot a graph of braking distance against speed.

Draw a line of best fit through your points.



Speed in metres per second

**(3)**

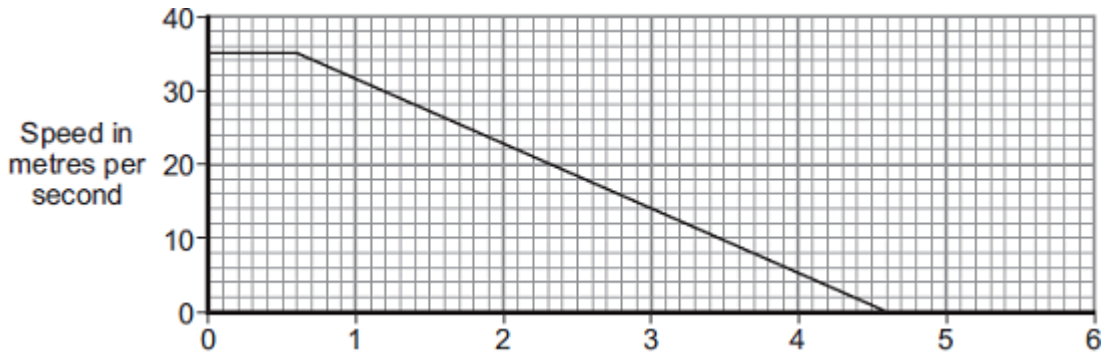
(ii) Use your graph to determine the braking distance, in metres, at a speed of 22 m / s.

Braking distance = ..... m

**(1)**

(d) The speed–time graph for a car is shown below.

While travelling at a speed of 35 m / s, the driver sees an obstacle in the road at time $t = 0$. The driver reacts and brakes to a stop.




Time in seconds

(i) Determine the braking distance.

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Braking distance = ..... m

**(3)**

(ii) If the driver was driving at 35 m / s on an icy road, the speed–time graph would be different.

Add another line to the speed–time graph above to show the effect of travelling at 35 m / s on an icy road and reacting to an obstacle in the road at time $t$ = 0.

**(3)**

(e) A car of mass 1200 kg is travelling with a velocity of 35 m / s.

(i) Calculate the momentum of the car.

Use the correct equation from **Section A** of the Physics Equations Sheet.

Give the unit.

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Momentum = .....

**(3)**

(ii) The car stops in 4 seconds.

Calculate the average braking force acting on the car during the 4 seconds.

Use the correct equation from **Section A** of the Physics Equations Sheet.

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Force = ..... N

**(2)**

**(Total 19 marks)**

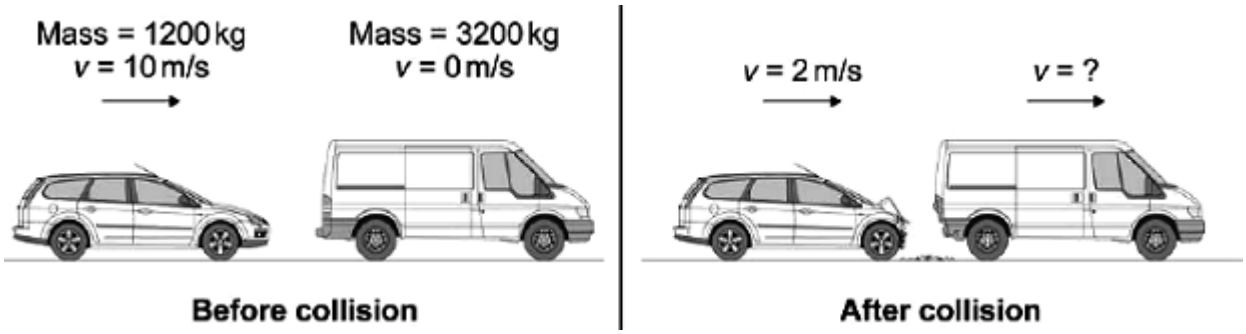
**Q4.**(a) Complete the sentence.

In a closed system, when two objects collide, the total momentum of the two objects before the collision is ..... the total momentum of the two objects after the collision.

**(1)**

(b) The diagram shows a car before and after the car collides with a stationary van.

The handbrake of the van is not on.




Use the information in the diagram to calculate the velocity, *v*, in metres per second, with which the van moves forwards after the collision.

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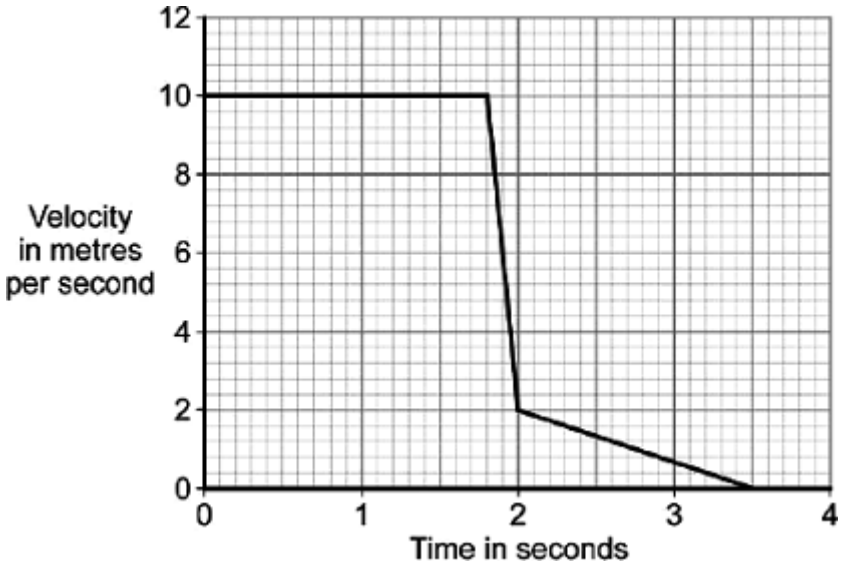
Velocity = ..... m/s

**(4)**

(c) The graph shows the velocity of the car before, during and after the collision.




Use the graph to calculate the distance travelled by the car, in metres, after the collision.

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Distance = ..... m

**(2)**

(d) The collision causes the car driver to jerk forward.

Explain why wearing a seat belt reduces the risk of the driver being injured in the collision.

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**(3)**

**(Total 10 marks)**