

Momentum

Question Paper

| | |
|------------------|----------------|
| Level | GCSE |
| Subject | Physics |
| Exam Board | AQA |
| Unit | P2 |
| Topic | Momentum |
| Difficulty Level | Bronze Level |
| Booklet | Question Paper |

Time Allowed: 100 minutes

Score: /100

Percentage: /100

Q1. A paintball gun is used to fire a small ball of paint, called a paintball, at a target.

The figure below shows someone just about to fire a paintball gun.

The paintball is inside the gun.



(a) What is the momentum of the paintball before the gun is fired?

.....

Give a reason for your answer.

.....

.....

(2)

(b) The gun fires the paintball forwards at a velocity of 90 m / s.

The paintball has a mass of 0.0030 kg.

Calculate the momentum of the paintball just after the gun is fired.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Momentum = kg m / s

(2)

(c) The momentum of the gun and paintball is conserved.

Use the correct answer from the box to complete the sentence.

| | | |
|----------|--------------|-----------|
| equal to | greater than | less than |
|----------|--------------|-----------|

The total momentum of the gun and paintball just after the gun is fired will be the total momentum of the gun and paintball before the gun is fired.

(1)
(Total 5 marks)

Q2. Some students designed and built an electric-powered go-kart. The go-kart is shown below.



(a) Suggest **two** changes that could be made to the design of the go-kart to increase its top speed.

1

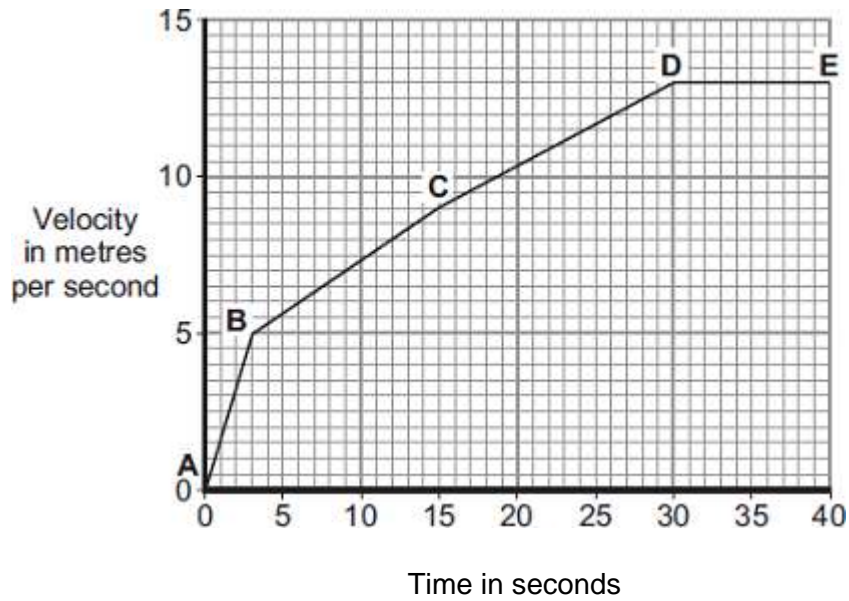
.....

2

.....

(2)

(b) A go-kart with a new design is entered into a race. The velocity-time graph for the go-kart, during the first 40 seconds of the race, is shown below.



- (i) Between which **two** points did the go-kart have the greatest acceleration?

Tick (✓) **one** box.

A–B

B–C

C–D

Give a reason for your answer.

.....

(2)

- (ii) The go-kart travels at a speed of 13 m/s between points **D** and **E**.
 The total mass of the go-kart and driver is 140 kg.

Calculate the momentum of the go-kart and driver between points **D** and **E**.

Use the correct equation from the Physics Equations Sheet.

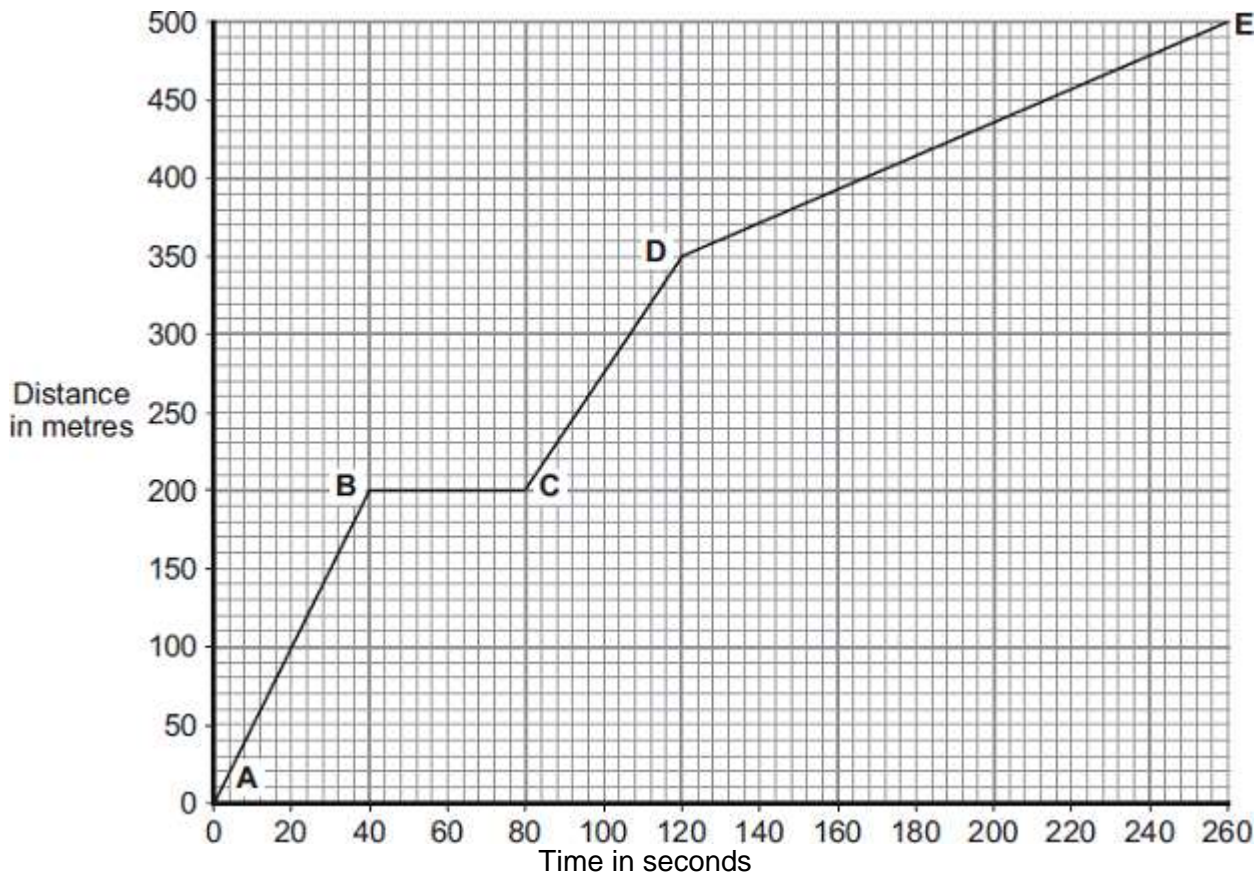
.....

Momentum = kg m/s

(2)
(Total 6 marks)

Q3. Part of a bus route is along a high street.

The distance-time graph shows how far the bus travelled along the high street and how long it took.



(a) Between which two points was the bus travelling the slowest?

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

| Points | Tick (✓) |
|--------|----------|
| A – B | |
| C – D | |
| D – E | |

Give a reason for your answer.

.....
.....

(2)

- (b) The bus travels at 5 m/s between points **A** and **B**.
The bus and passengers have a total mass of 16 000 kg.

Use the equation in the box to calculate the momentum of the bus and passengers between points **A** and **B**.

| |
|----------------------------|
| momentum = mass x velocity |
|----------------------------|

Show clearly how you work out your answer.

.....
.....

Momentum = kg m/s

(2)

- (c) A cyclist made the same journey along the high street.
The cyclist started at the same time as the bus and completed the journey in 220 seconds. The cyclist travelled the whole distance at a constant speed.

- (i) Draw a line on the graph to show the cyclist's journey.

(2)

- (ii) After how many seconds did the cyclist overtake the bus?

The cyclist overtook the bus after seconds.

(1)

(Total 7 marks)

- Q4.** (a) The diagram shows a cricketer bowling a ball.



- (i) The cricketer bowls the ball at 20 m/s.

How could the kinetic energy of **this** ball have been increased?

.....

(1)

- (ii) The ball has a mass of 0.16 kg.

Use the equation in the box to calculate the momentum of the ball when it is bowled at 20 m/s.

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

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

Choose the unit from the list below.

kg m/s

m/s²

Nm

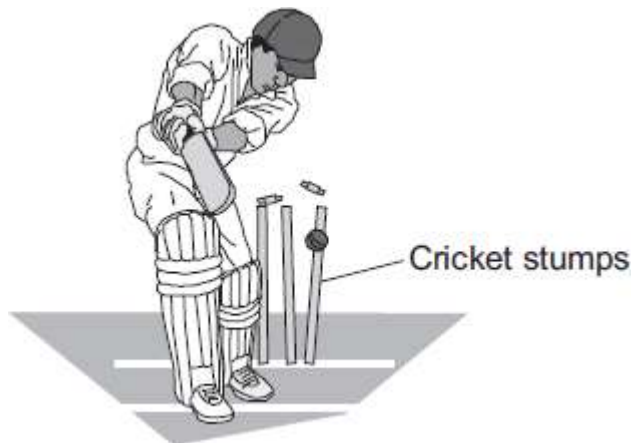
.....

.....

Momentum =

(3)

- (b) The batsman misses the ball and the ball hits the cricket stumps.



As the ball hits the stumps, the ball loses both kinetic energy and momentum.

- (i) What happens to the kinetic energy lost by the ball?

.....
.....

(1)

- (ii) Even though the ball loses momentum, the total momentum of the ball **and** stumps just before the ball hits the stumps is the same as the total momentum of the ball **and** stumps just after the collision.

Explain how this is possible.

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.....
.....
.....

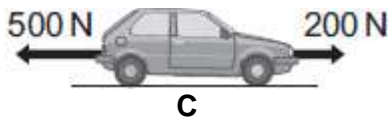
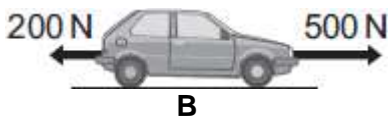
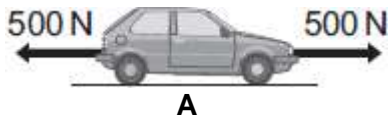
(2)

(Total 7 marks)

- Q5. (a) The diagrams, **A**, **B** and **C**, show the horizontal forces acting on a **moving** car.

Draw a line to link each diagram to the description of the car's motion at the moment when the forces act.

Draw only **three** lines.



stationary

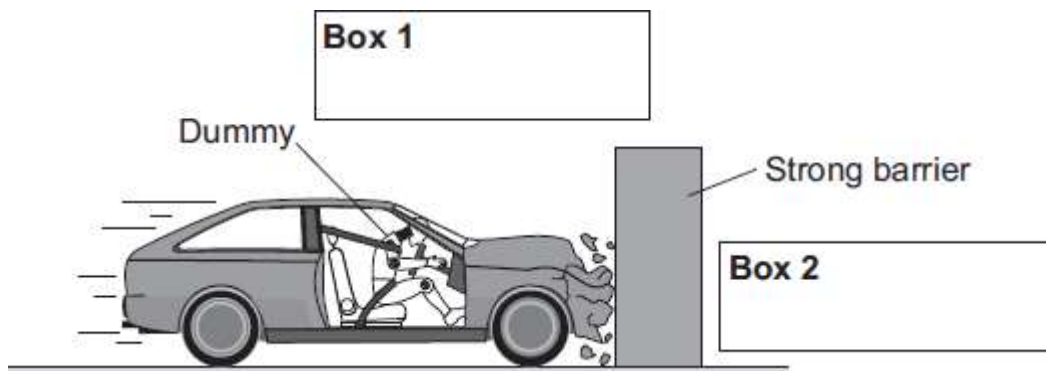
constant speed

slowing down

accelerating forwards

(3)

- (b) The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to a dummy inside the car.



- (i) Draw an arrow in **Box 1** to show the direction of the force that the car exerts on the barrier.

(1)

- (ii) Draw an arrow in **Box 2** to show the direction of the force that the barrier exerts on the car.

(1)

- (iii) Complete the following by drawing a ring around the correct line in the box.

The car exerts a force of 5000 N on the barrier. The barrier does not move.
The force

exerted by the barrier on the car will be

| |
|-----------|
| more than |
| equal to |
| less than |

5000 N.

(1)

- (iv) Which **one** of the following gives the most likely reason for attaching electronic sensors to the dummy?

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

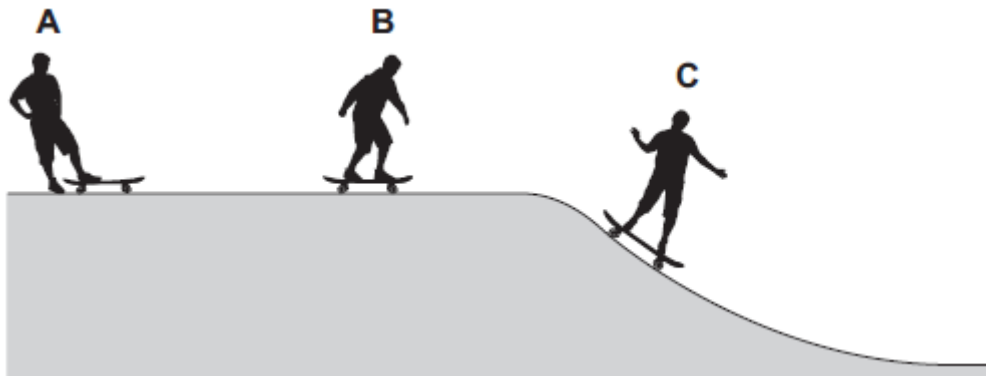
To measure the speed of the car just before the impact.

To measure the forces exerted on the dummy during the impact.

To measure the distance the car travels during the impact.

(1)
(Total 7 marks)

Q6. The picture shows three skateboarders, **A**, **B** and **C**.



Skateboarder **A** is not moving.

Skateboarder **B** is moving towards the ramp at a constant speed.

Skateboarder **C** is moving on the ramp at a constant speed.

(a) The skateboarders have different amounts of kinetic energy.

Which **two** factors affect the kinetic energy of the skateboarders?

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

direction and mass

mass and speed

speed and direction

(1)

(b) The skateboarders also have different amounts of momentum.

(i) Which **one** of the skateboarders has the smallest amount of momentum?

Draw a ring around your answer.

A

B

C

Give a reason for your answer.

.....

.....

(2)

- (ii) Skateboarder **B** has a mass of 55 kg.

Use the equation in the box to calculate the momentum of skateboarder **B** when moving at 4 m/s.

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

Show clearly how you work out your answer.

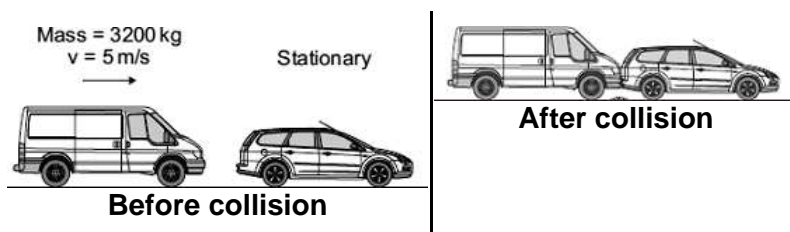
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Momentum = kg m/s

(2)

(Total 5 marks)

- Q7.** (a) A van has a mass of 3200 kg. The diagram shows the van just before and just after it collides with the back of a car.



Just before the collision, the van was moving at 5 m/s and the car was stationary.

- (i) Use the equation in the box to calculate the momentum of the van just before the collision.

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

Show clearly how you work out your answer.

.....
.....

Momentum = kg m/s

(2)

(ii) The collision makes the van and car join together.

What is the total momentum of the van and the car just after the collision?

Momentum = kg m/s

(1)

(iii) Complete the following sentence by drawing a ring around the correct line in the box.

The momentum of the car before the collision is

| |
|-------------|
| more than |
| the same as |
| less than |

the

momentum of the car after the collision.

(1)

(b) A seat belt is one of the safety features of a car.



In a collision, wearing a seat belt reduces the risk of injury.

Use words or phrases from the box to complete the following sentences.

| | | |
|-----------|----------------|-----------|
| decreases | stays the same | increases |
|-----------|----------------|-----------|

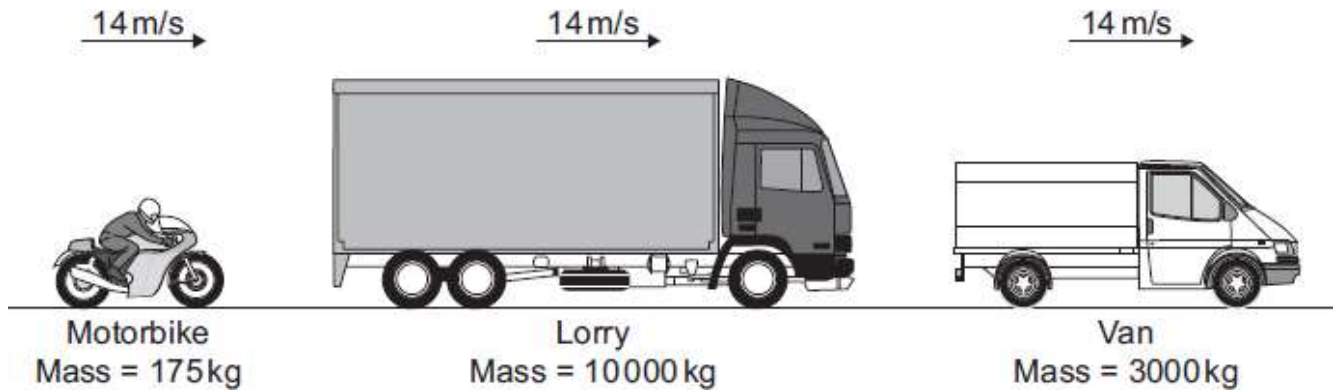
In a collision, the seat belt stretches. The time it takes for the person held by the seat belt to lose momentum compared to a person not wearing a seat belt,

.....

The force on the person's body
and so reduces the risk of injury.

(2)
(Total 6 marks)

- Q8.** (a) (i) The diagram shows three vehicles travelling along a straight road at 14 m/s.



Which vehicle has the greatest momentum?

.....

Give the reason for your answer.

.....

(2)

- (ii) Use the equation in the box to calculate the momentum of the motorbike when it travels at 14 m/s.

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

Show clearly how you work out your answer.

.....

Momentum =kg m/s

(2)

- (b) The motorbike follows the lorry for a short time, and then accelerates to overtake both the lorry and van.
- (i) Complete the following sentence by drawing a ring around the correct line in the box.

When the motorbike starts to overtake, the kinetic energy

of the motorbike

| |
|-----------------|
| decreases. |
| stays the same. |
| increases. |

(1)

(ii) Give a reason for your answer to part (b)(i).

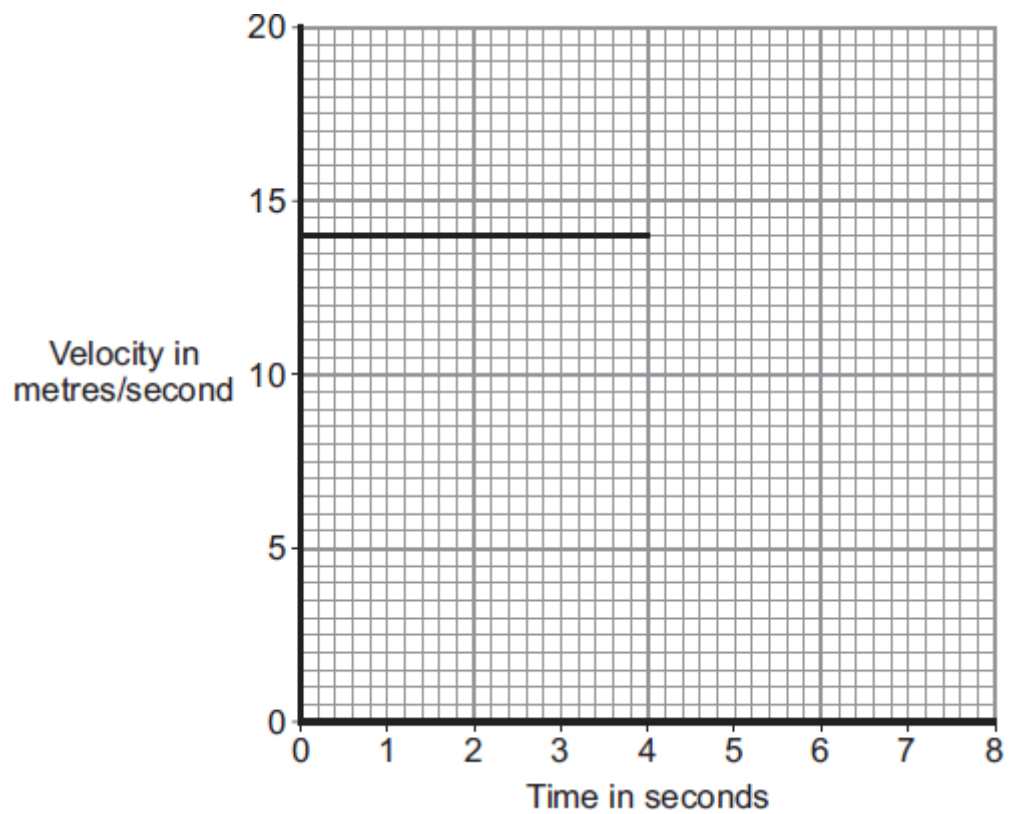
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.....

(1)

(iii) The graph shows the velocity of the motorbike up to the time when it starts to accelerate. The motorbike accelerates constantly, going from a speed of 14 m/s to a speed of 20 m/s in a time of 2 seconds. The motorbike then stays at 20 m/s.

Complete the graph to show the motion of the motorbike over the next 4 seconds.



(3)
(Total 9 marks)

Q9. Motorway accidents have many causes.

- (a) Which **one** of the following is most likely to increase the chance of a car being in an accident?

Tick (✓) the box next to your answer.

The car has just had new tyres fitted.

The driver has been drinking alcohol.

A road surface in dry conditions

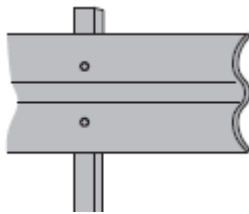


Give a reason for your answer.

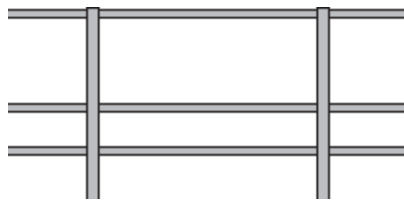
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(2)

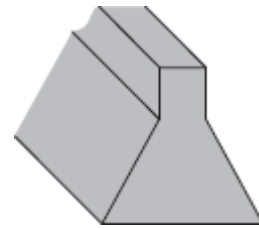
(b) The diagram shows three designs of motorway crash barriers.



Steel sheets



Steel 'ropes'



Solid concrete

Before a new design of barrier is used, it must be tested.

A car of mass 1500 kg is driven at 30 m/s to hit the barrier at an angle of 20 degrees.

This barrier must slow the car down and must not break.

Explain why the mass of the car, the speed of the car and the angle at which the car hits the barrier must be the same in every test.

.....
.....
.....
.....
.....

(2)

(c) A group of scientists has suggested that new designs of crash barriers should be first tested using computer simulations.

Which **two** statements give sensible reasons for testing new barrier designs using a computer simulation?

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

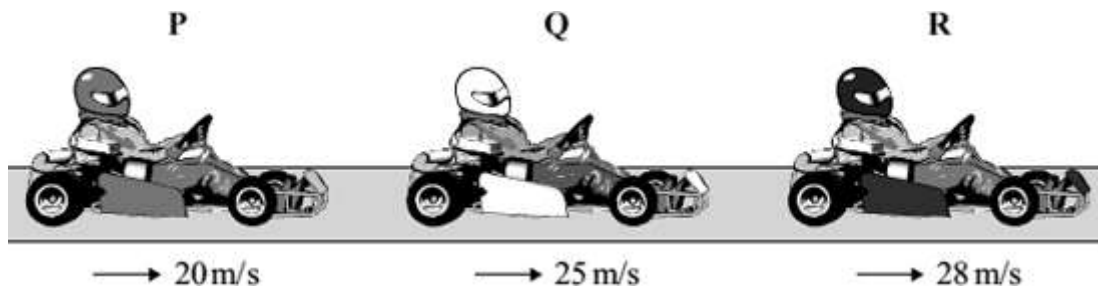
The design of the barrier can be changed easily.

Data for different conditions can be obtained quickly.

Simulations are more realistic than using cars and barriers.

(1)
(Total 5 marks)

Q10. (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)

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

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

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

Show clearly how you work out your answer.

.....
.....

Momentum =

(2)

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

Draw a ring around your answer.

| | | |
|------------|---------------|-----------|
| J/s | kg m/s | Nm |
|------------|---------------|-----------|

(1)

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

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

.....

(1)

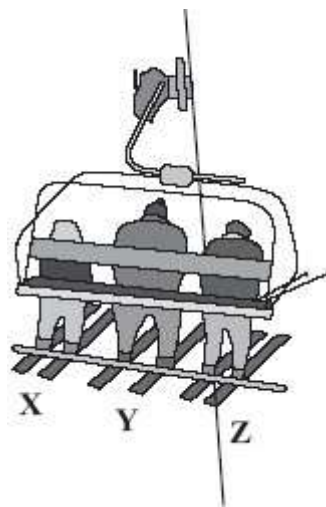
(ii) How would a wet track affect the braking distance of a go-kart?

.....

(1)

(Total 7 marks)

- Q11. (a) The diagram shows three skiers, X, Y and Z, on a moving chairlift. The mass of each skier is given in the table.



| Skier | Mass in kg |
|-------|------------|
| X | 65 |
| Y | 90 |
| Z | 80 |

Which **one** of the skiers, X, Y or Z, has the most momentum?

.....

Give the reason for your answer.

.....

.....

(2)

- (b) At one point in the journey, the chairlift accelerates to a higher speed.

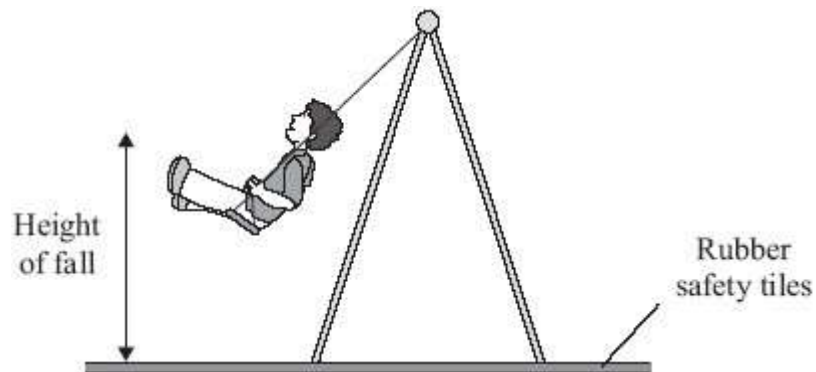
What happens to the momentum of the three skiers as the chairlift accelerates?

.....

(1)

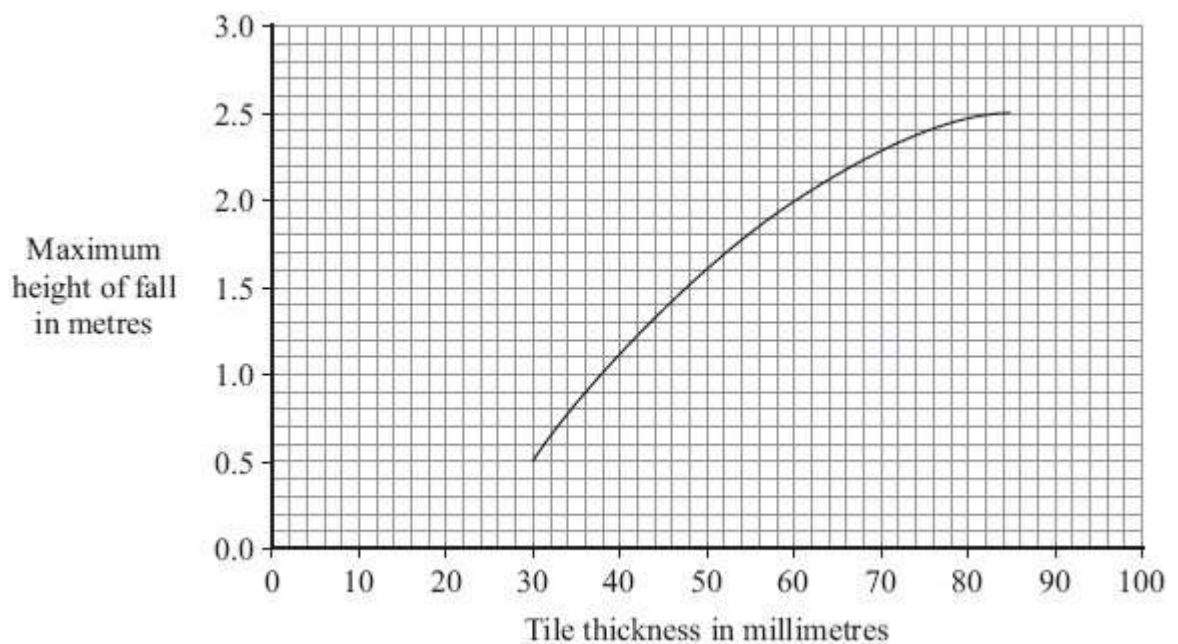
(Total 3 marks)

Q12. The diagram shows a child on a playground swing.



- (a) The playground surface is covered in rubber safety tiles. The tiles reduce the risk of serious injury to children who fall off the swing.

The graph gives the maximum height that a child can fall onto rubber safety tiles of different thicknesses and be unlikely to get a serious head injury.



- (i) Describe how the maximum height of fall relates to the thickness of the rubber safety tile.

.....
.....

(1)

- (ii) The maximum height of any of the playground rides is 2 metres.
What tile thickness should be used in the playground?

.....

Give a reason for your answer.

.....
.....

(2)

- (b) Use phrases from the box to complete the following sentences.

| |
|--|
| the force on the work done to stop the time taken to stop |
|--|

- (i) Falling onto a rubber surface compared to a hard surface increases
..... the child.

(1)

- (ii) Momentum is lost more slowly falling onto a rubber surface than on a hard surface.

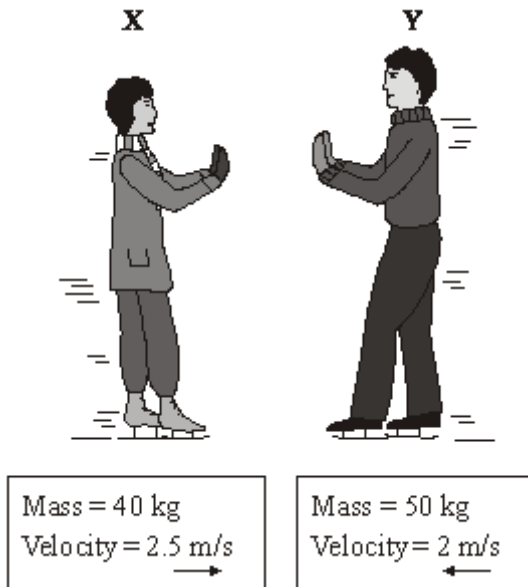
This reduces the child.

(1)

(Total 5 marks)

Q13. The picture shows two children, **X** and **Y**, skating towards each other at an ice rink.

The children collide with each other, fall over and stop.



(a) Before the collision the children had different amounts of kinetic energy.

(i) What are the **two** factors that determine the kinetic energy of the children?

1

2

(2)

(ii) What was the total kinetic energy of the children after they had fallen over and stopped?

.....

(1)

(b) The total momentum of the children before and after the collision is zero.

- (i) Use the equation in the box and the data given in the diagram to calculate the momentum of child Y before the collision.

| |
|----------------------------|
| momentum = mass x velocity |
|----------------------------|

Show clearly how you work out your answer.

.....
.....

Momentum = kg m/s

(2)

- (ii) Complete the following sentence using one of the words in the box.

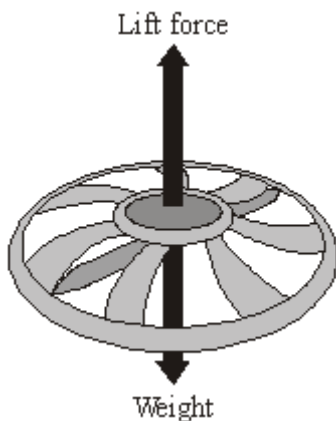
| | | |
|-----------|-----------|-----------|
| conserved | decreased | increased |
|-----------|-----------|-----------|

The total momentum of the two children was

(1)

(Total 6 marks)

- Q14.** The diagram shows the forces on a small, radio-controlled, flying toy.



- (a) (i) The mass of the toy is 0.06 kg.
Gravitational field strength = 10 N/kg

Use the equation in the box to calculate the weight of the toy.

| |
|--|
| $\text{weight} = \text{mass} \times \text{gravitational field strength}$ |
|--|

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

.....
.....

Weight =

(3)

- (ii) Complete the following sentence by drawing a ring around the correct line in the box.

When the toy is hovering stationary in mid-air, the lift force is

| | |
|--------------|------------------------|
| bigger than | the weight of the toy. |
| the same as | |
| smaller than | |

(1)

- (b) When the motor inside the toy is switched off, the toy starts to *accelerate* downwards.

- (i) What does the word *accelerate* mean?

.....

(1)

- (ii) What is the direction of the resultant force on the falling toy?

.....

(1)

(iii) Does the momentum of the toy increase, decrease or stay the same?

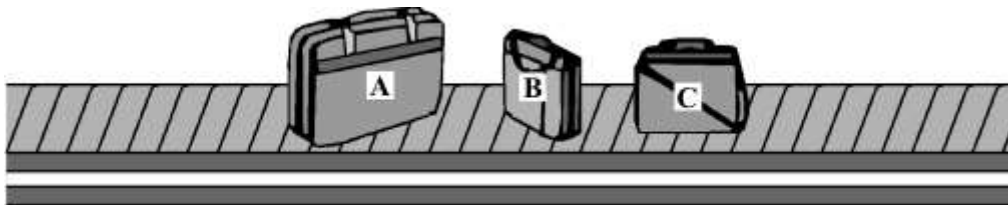
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Give a reason for your answer.

.....

(2)
(Total 8 marks)

Q15. The picture shows luggage which has been loaded onto a conveyor belt.



Each piece of luggage has a different mass.

Mass of **A** = 22 kg mass of **B** = 12 kg mass of **C** = 15 kg

(a) (i) What is the momentum of the luggage before the conveyor belt starts to move?

.....

Give a reason for your answer.

.....

.....

(2)

- (ii) When the conveyor belt is switched on the luggage moves with a constant speed. Which piece of luggage **A**, **B** or **C** has the most momentum?

.....

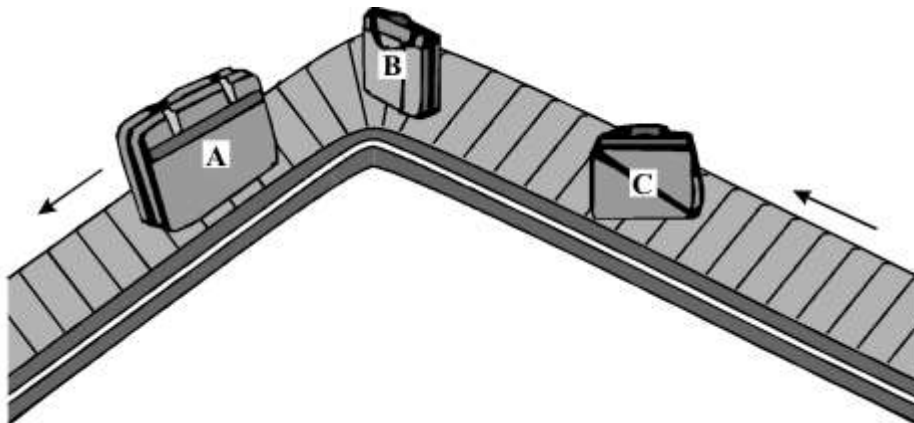
Give a reason for your answer.

.....

.....

(2)

- (iii) At one point the conveyor belt turns left. The luggage on the belt continues to move at a constant speed.



Does the momentum of the luggage change as it turns left with the conveyor belt?

.....

Give a reason for your answer.

.....

.....

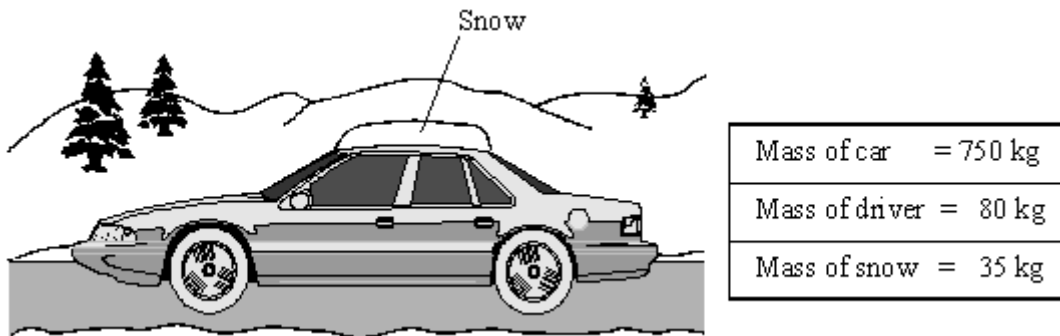
(2)

- (b) Draw a circle around the unit which can be used to measure momentum.

J/s kg m/s Nm

(1)
(Total 7 marks)

Q16. (a) The diagram shows a car being driven at 14 m/s. The driver has forgotten to clear a thick layer of snow from the roof.



Which of the following has the smallest momentum? Draw a circle around your answer.

the car the driver the snow

Give a reason for your answer.

.....

(2)

(b) Seeing an obstacle in the road, the driver applies the car brakes. The car slows down in a straight line.

(i) Does the momentum of the car increase, decrease or stay the same?

.....

Give a reason for your answer.

.....

(2)

- (ii) As the car slows down the snow starts to slide. In which direction will the snow start to slide, backwards, forwards or sideways?

.....

Give a reason for your choice of direction.

.....

(2)

- (c) Draw a circle around the unit which can be used to measure momentum.

Nm

J/s

Ns

(1)

(Total 7 marks)