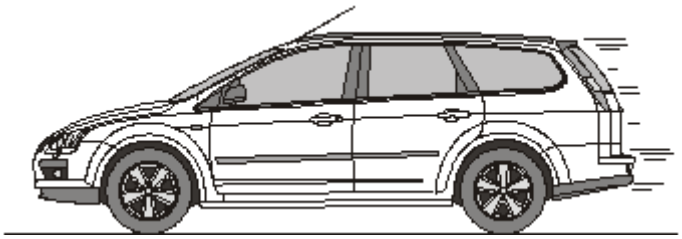
Q1.

(a) The diagram shows a car travelling at a speed of 12 m/s along a straight road.



(i) Calculate the momentum of the car.

Mass of the car = 900 kg

Show clearly how you work out your answer.

_____

_____

_____

_____

Momentum = _____ kg m/s

(2)

(ii) Momentum has direction.

Draw an arrow on the diagram to show the direction of the car's momentum.

(1)

(b) The car stops at a set of traffic lights.

How much momentum does the car have when it is stopped at the traffic lights?

_____

Give a reason for your answer.

_____

_____

_____

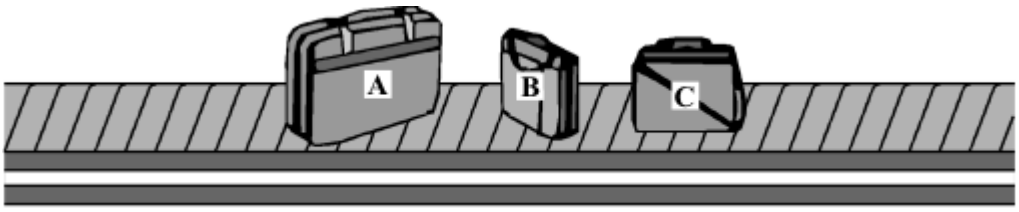
_____

(2)

(Total 5 marks)

Q2.

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** = l2 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?

_____

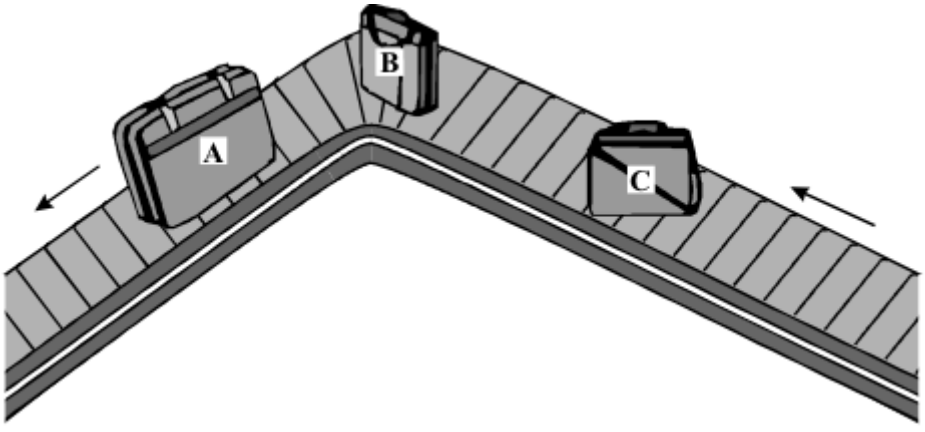
Give a reason for your answer.

_____

_____

(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.

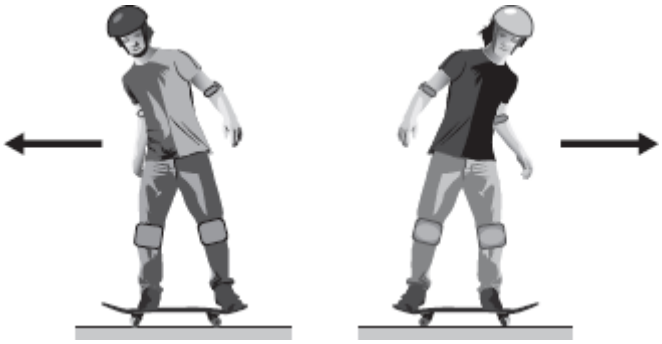
J/s kg m/s Nm

(1)

(Total 7 marks)

Q3.

(a) The picture shows two teenagers riding identical skateboards.
The skateboards are moving at the same speed and the teenagers have the same mass.



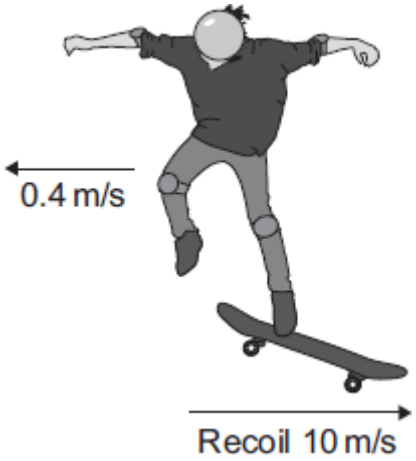
Why do the teenagers **not** have the same momentum?

_____

_____

(1)

(b) One of the skateboards slows down and stops. The teenager then jumps off the skateboard, causing it to recoil and move in the opposite direction.



The momentum of the teenager and skateboard is conserved.

(i) What is meant by 'momentum being conserved'?

_____

_____

(1)

(ii) The teenager, of mass 55 kg, jumps off the skateboard at 0.4 m/s causing the skateboard to recoil at 10 m/s.

Calculate the mass of the skateboard.

_____

_____

_____

Mass = _____ kg

(3)

(c) Once the skateboard starts to recoil, it soon slows down and its kinetic energy decreases.

Explain why.

_____

_____

_____

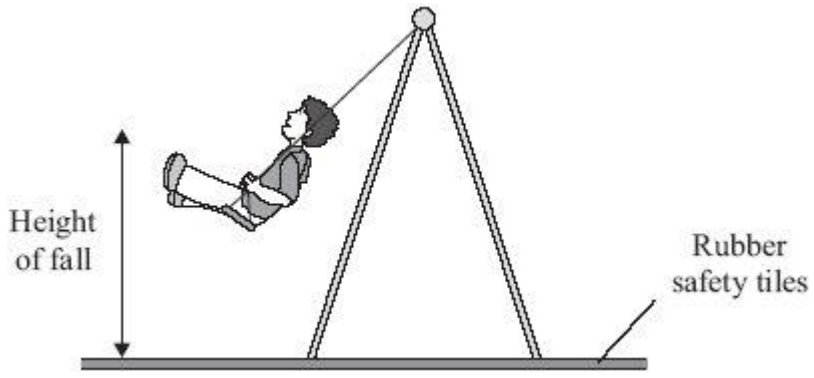
_____

(2)

(Total 7 marks)

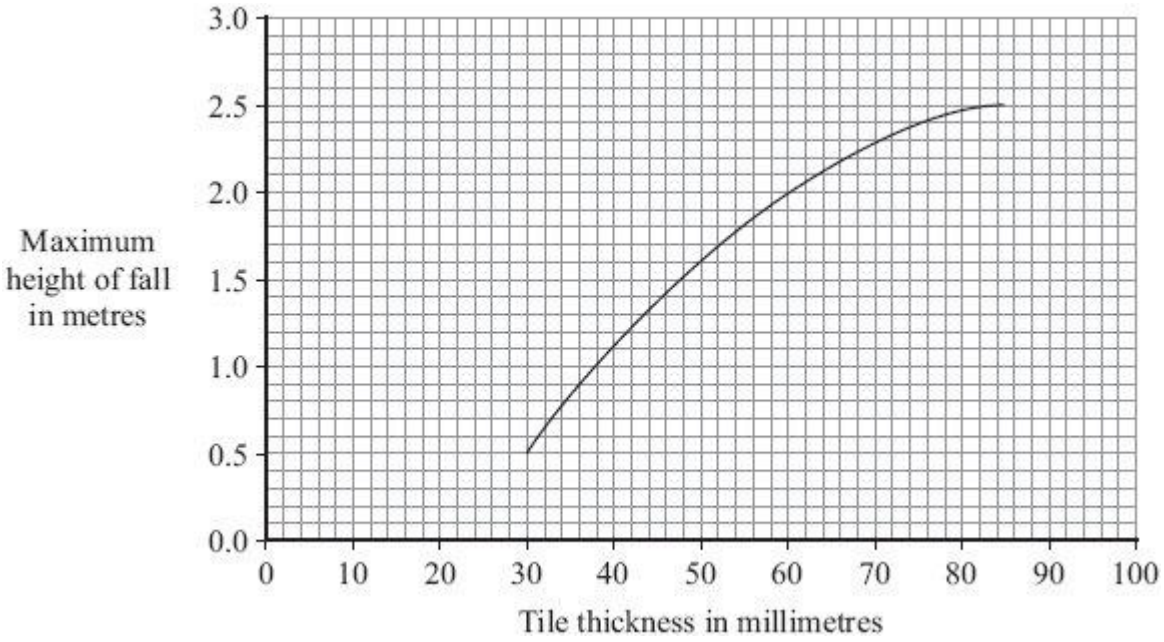
Q4.

The diagram shows a child on a playground swing.



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)

(Total 3 marks)

Q5.

(a) Complete the following sentence.

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

and a _____ .

(1)

(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.

Calculate the average force exerted by the lorry on the car during the collision.

Show clearly how you work out your answer.

_____

_____

Force = _____ N

(2)

(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 drive sustaining a serious head injury.

_____

_____

_____

_____

_____

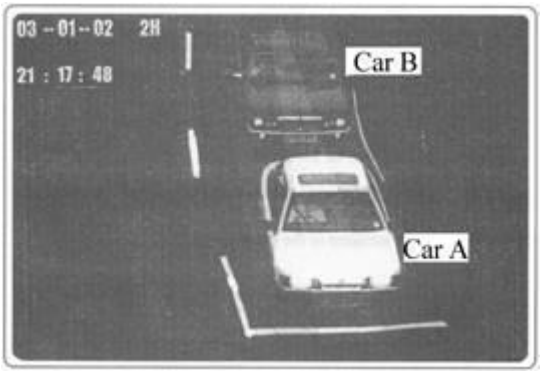
_____

(3)

(Total 6 marks)

Q6.

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.

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

_____

(1)

(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)

(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)

(Total 7 marks)

Q1.

(a) (i) 10800

allow 1 mark for correct substitution i.e. 900 × 12

2

(ii) arrow pointing towards the left

allow anywhere on the diagram or at bottom of the page

1

(b) zero

accept 0 / none / nothing

1

velocity is zero

accept speed for velocity
accept stopped / not moving
accept a calculation i.e. 900 × 0 = 0

1

[5]

Q2.

(a) (i) zero

accept nothing

1

speed is zero

accept not moving

1

(ii) A

1

largest mass **or** weight

accept heaviest luggage
*do **not** accept largest luggage*

1

(iii) momentum does change

accept yes

1

direction is changing

accept velocity is changing
*do **not** accept answers in terms of speed changing*

1

(b) kg m/s

1

[7]

Q3.

(a) (moving in) different / opposite directions

accept one has positive momentum the other negative momentum

accept they have different velocities

1

(b) (i) momentum before = momentum after

or

(total) momentum stays the same

accept no momentum is lost

accept no momentum is gained

1

(ii) 2.2

*allow **1** mark for calculation of teenagers' momentum as 22 (kgm/s) and*

*allow **1** mark for correct statement, eg momentum before = momentum after*

or

*allow **2** marks for a numerical expression of above, eg*

55 × 0.4 = m × 10

***or** 0 = (55 × 0.4) + (m × (-10))*

3

(c) any **two** from:

- work is done
- (against) friction

  any reference to increasing friction negates this marking point

- (transforming) (kinetic) energy into heat

2

[7]

Q4.

(i) the thicker the tile, the greater the(fall) height

accept the higher (the fall) the thicker the tile
accept there is a positive correlation
*do **not** accept they are proportional*

1

(ii) 60 (mm)

accept any number or range between 60 and 85 inclusive
if units are given must match range

1

(minimum thickness) needed to <u>reduce risk of injury</u>

reason must match thickness choice
*do **not** accept to keep child safe*

accept an answer in terms of – the thicker the tile, the less

chance there is of a serious injury if the answer given is greater than 60

accept answers in terms of use of graph e.g. the graph shows that for a 2m fall a thickness of 60 mm is needed

minimum level answer' the graph shows that's what's needed' accept only if 60 is the answer

1

[3]

Q5.

(a) direction

1

(b) 54 000

*allow **1** mark for calculating and identifying momentum as 10 800*

or

*allow **1** mark for correct substitution into second equation*

ie $\frac{1200 \times 9}{0.2}$

2

(c) increases the time taken (for head) to stop

accept increases impact time

*do **not** accept reference to slowing down time unless qualified*

1

decreases rate of change in momentum

accept reduces acceleration / deceleration

*accept increases the time taken to reduce momentum to zero is worth **2** marks*

reduces momentum is insufficient

1

reduces the <u>force</u> (on the head)

1

[6]

Q6.

(i) momentum (change in) = mass × velocity (change in)

accept ... speed

1

(ii) 9000

*1500 × 6 for 1 mark but **not** from incorrect equation*

2

kilogram metre(s) per second **or** kg m/s

1

(iii) **either** 7.5 (m/s)

or change in momentum of car B change in momentum of car A (1)
9000 = 1200 × v (1)

or v = 9000 ÷ 1200 (1)

or error carried forward from part (ii)

examples

5 (m/s) if 6000 offered in (ii) (3)

12.5(m/s) if 15000 offered in (ii) (3)

3

[7]