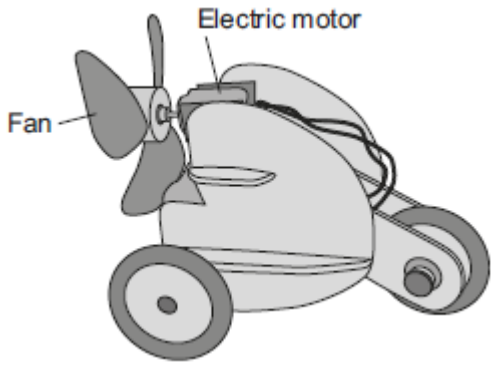
Q1.

The diagram shows an air-driven toy.
When the electric motor is switched on the fan rotates.
The fan pushes air backwards making the toy move forwards.



(a) (i) The toy has a mass of 0.15 kg and moves forward with a velocity of 0.08 m/s.

How is the momentum of the toy calculated?

Tick (✓) **one** box.

0.15 + 0.08 = 0.230 ☐

0.15 ÷ 0.08 = 1.875 ☐

0.15 × 0.08 = 0.012 ☐

(1)

(ii) What is the unit of momentum?

Tick (✓) **one** box.

kg m/s ☐ m/s^2 ☐ kg/m/s ☐

(1)

(iii) Use the correct answer from the box to complete the sentence.

less than	**equal to**	**more than**

The momentum of the air backwards is _____ the momentum of the toy forwards.

(1)

(b) The electric motor can rotate the fan at two different speeds.

Explain why the toy moves faster when the fan rotates at the higher of the two

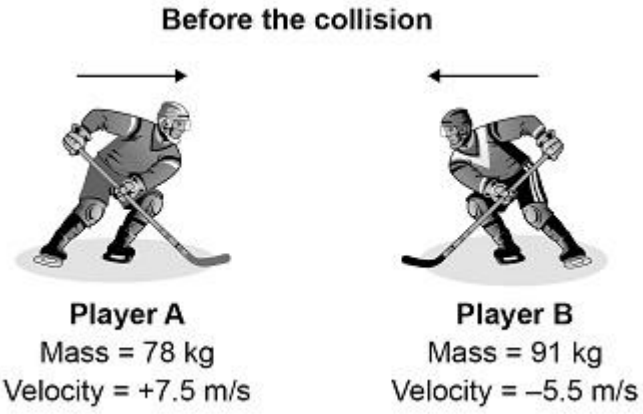
speeds.

(2)
(Total 5 marks)

Q2.

The image below shows two ice hockey players moving towards each other.

They collide and then move off together.



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

(a) What is meant by ‘momentum is conserved’?

(1)

(b) Immediately after the collision the two players move together to the right.

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

Velocity = _____ m/s

(4)

(c) The ice hockey players wear protective pads filled with foam.

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

(3)

(Total 8 marks)

Q3.

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.

_____

_____

_____

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)

Q4.

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

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

_____

_____

(1)

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

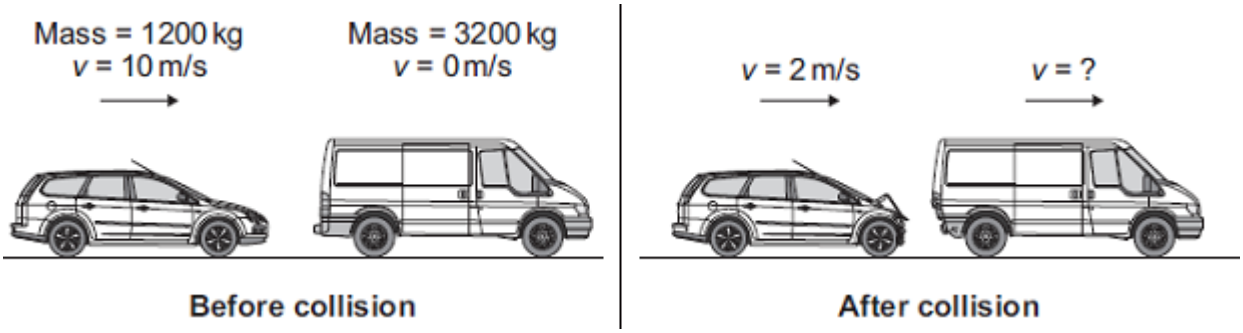
Why?

_____

_____

(1)

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



(i) Use the information in the diagram to calculate the **change** in the momentum of the car.

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

_____

_____

_____

_____

Change in momentum = _____

(3)

(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.

_____

_____

_____

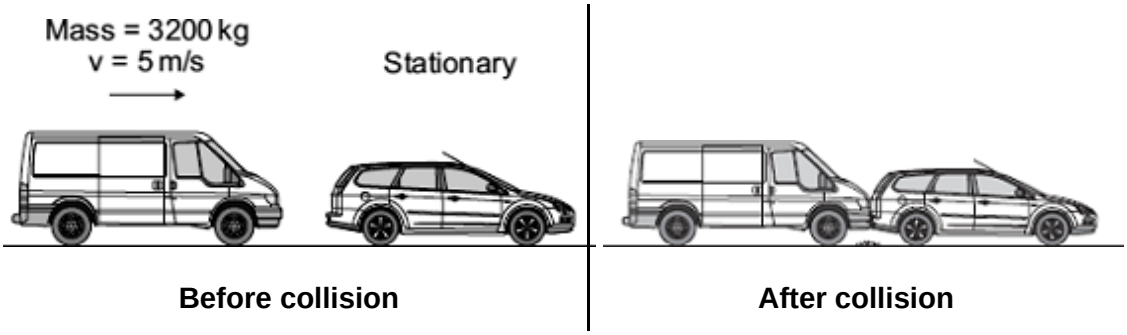
Velocity = _____ m/s forward

(2)

(Total 7 marks)

Q5.

(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) Calculate the momentum of the van just before the collision.

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)

Q6.

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

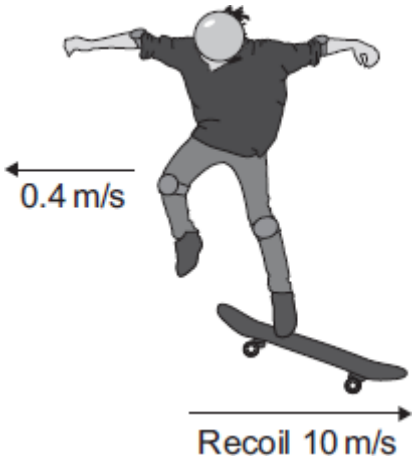
Why do the teenagers **not** have the same momentum?

_____

_____

(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)

Q1.

(a) (i) 0.15 × 0.08 = 0.012

1

(ii) kg m/s

1

(iii) equal to

1

(b) momentum of the air increases
or
force backwards increases

accept air moves faster
accept momentum backwards increases
accept pushes more air back(wards)

1

so momentum of the toy must increase
or
the force forwards (on the toy) increases

accept momentum forwards must increase
it = toy

1

[5]

Q2.

(a) (total) momentum before = (total) momentum after

allow (total) momentum stays the same

1

(b) momentum of player A = 585 (kg m/s)

1

momentum of player B = –500.5 (kg m/s)

1

$$\frac{(-500.5 + 585)}{(78 + 91)}$$

OR

$$\frac{84.5}{169}$$

allow $\frac{1085.5}{169}$

1

= 0.5 (m/s)

this answer only

1

(c) (protective pads) increase the time taken to stop (during the collision)

allow increases impact / contact / collision time
*do **not** allow slows down time*

1

so the rate of change of momentum decreases

allow reduces acceleration/deceleration

*allow increases the time to reduce the momentum to zero for **2** marks*

1

reducing the force (on the ice hockey player)

allow impact for force

*do **not** allow if linked to an incorrect explanation*

1

[8]

Q3.

(a) Zero / 0

Accept none

Nothing is insufficent

1

velocity / speed = 0

accept it is not moving

paintball has not been fired is insufficient

1

(b) 0.27

*allow **1** mark for correct substitution, ie p = 0.003(0) × 90 provided no subsequent step*

2

(c) equal to

1

[5]

Q4.

(a) (i) momentum before = momentum after

accept no momentum is lost

accept no momentum is gained

or

(total) momentum stays the same

1

(ii) an external force acts (on the colliding objects)

accept colliding objects are not isolated

1

(b) (i) 9600

allow 1 mark for correct calculation of momentum before or after ie 12000 or 2400

or
correct substitution using change in velocity = 8 m/s
ie 1200 × 8

2

kg m/s
or
Ns

this may be given in words rather than symbols
*do **not** accept nS*

1

(ii) 3 or their (b)(i) 3200 correctly calculated

allow 1 mark for stating momentum before = momentum after

or

clear attempt to use conservation of momentum

2

[7]

Q5.

(a) (i) 16 000

*allow **1** mark for correct substitution ie 3200 × 5*

2

(ii) 16 000 or their (a)(i)

1

(iii) less than

1

(b) increases

1

decreases

correct order only

1

[6]

Q6.

(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]