2.4 Momentum & Impulse

Question Paper

Course	DP IB Physics (HL)
Section	2. Mechanics
Topic	2.4 Momentum & Impulse
Question Set	Structured Questions
Difficulty	Easy

Time Allowed 80

Score /64

Percentage /100

Check your answers

Question 1a

(i) Write an equation for the momentum of an object in words

[1]

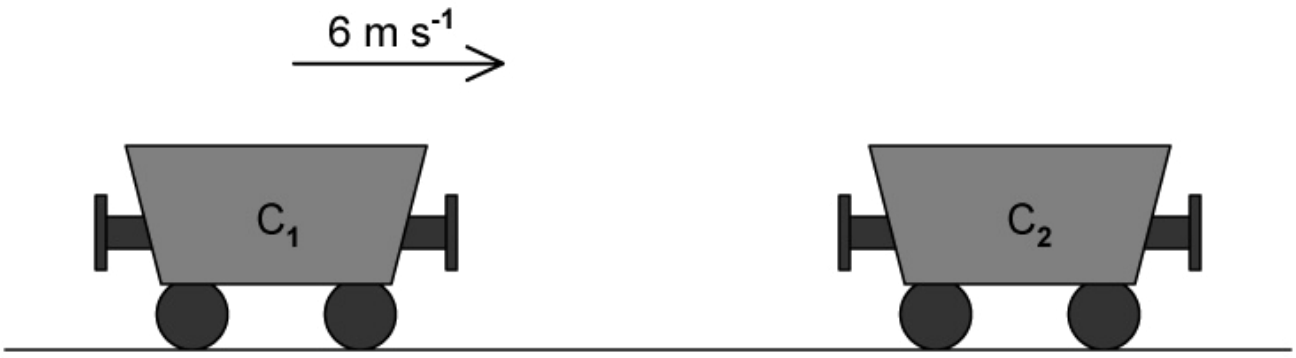
(ii) State the fundamental SI units of momentum

[1]

[2 marks]

Question 1b

A railway carriage, C_1, of mass 1100 kg is rolling along a horizontal track at a speed of 6 m s^{-1} towards a stationary carriage, C_2, as shown below. Carriage C_2 has a mass of 3300 kg.



Calculate:

(i) The initial momentum of carriage C_1 before the collision

[2]

(ii) The initial momentum of carriage C_2 before the collision.

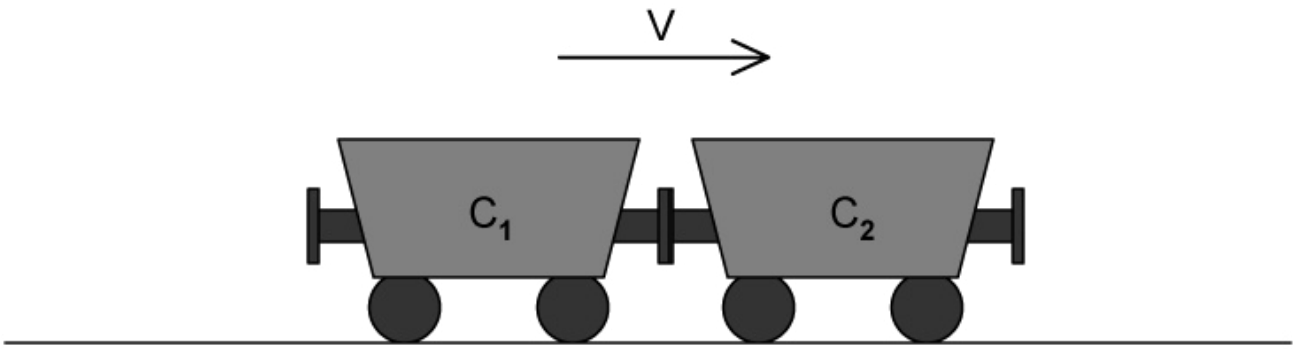
[1]

[3 marks]

Question 1c

At the moment of collision, both carriages C_1 and C_2, become joined.

The joined carriages move off with a velocity, *v*, as shown below.



Calculate the total momentum of C_1 and C_2 after they have joined.

Use your answers from part (b) and the conservation of momentum.

[3 marks]

Question 1d

Calculate the velocity, *v*, at which the carriages C_1 and C_2 move after becoming joined.

[3 marks]

Question 2a

A film stuntman, of mass 85.0 kg, is being trained to jump off high objects.

In one scene he steps off a roof and falls vertically to the ground below. Just before he hits the ground he has a velocity of 9.08 m s^{-1}. After he has landed on the ground he remains at rest.

Calculate the momentum of the stuntman:

(i) Just before he hits the ground.

[2]

(ii) After he has landed.

[1]

[3 marks]

Question 2b

Using your answers to part (a), calculate the change of momentum of the stuntman during the landing.

[2 marks]

Question 2c

State the impulse experienced by the stuntman during landing.

Give an appropriate unit with your answer.

[2 marks]

Question 2d

When the stuntman keeps his legs fully rigid, the time for the impact is 4.20 ms.

Calculate the magnitude of the average resultant force acting on the stuntman's legs during this time.

[4 marks]

Question 3a

A bullet, of mass 20 g, leaves the barrel of a rifle, of mass 1.9 kg, with a momentum 4.0 kg m s^{-1}.

(i) State the total momentum of the rifle and the bullet before the rifle is fired

[1]

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

[1]

[2 marks]

Question 3b

Calculate the velocity of the bullet just after the rifle is fired.

[3 marks]

Question 3c

Use the principle of conservation of momentum and your answer to part (a) to:

(i) State the total momentum of the rifle and the bullet immediately after the rifle has been fired.

[2]

(ii) Calculate the recoil momentum of the rifle.

[2]

[4 marks]

Question 3d

The bullet has a momentum of 3 kg m s^{-1} just before it hits a target. It takes 0.0025 s for the bullet to be stopped by the target.

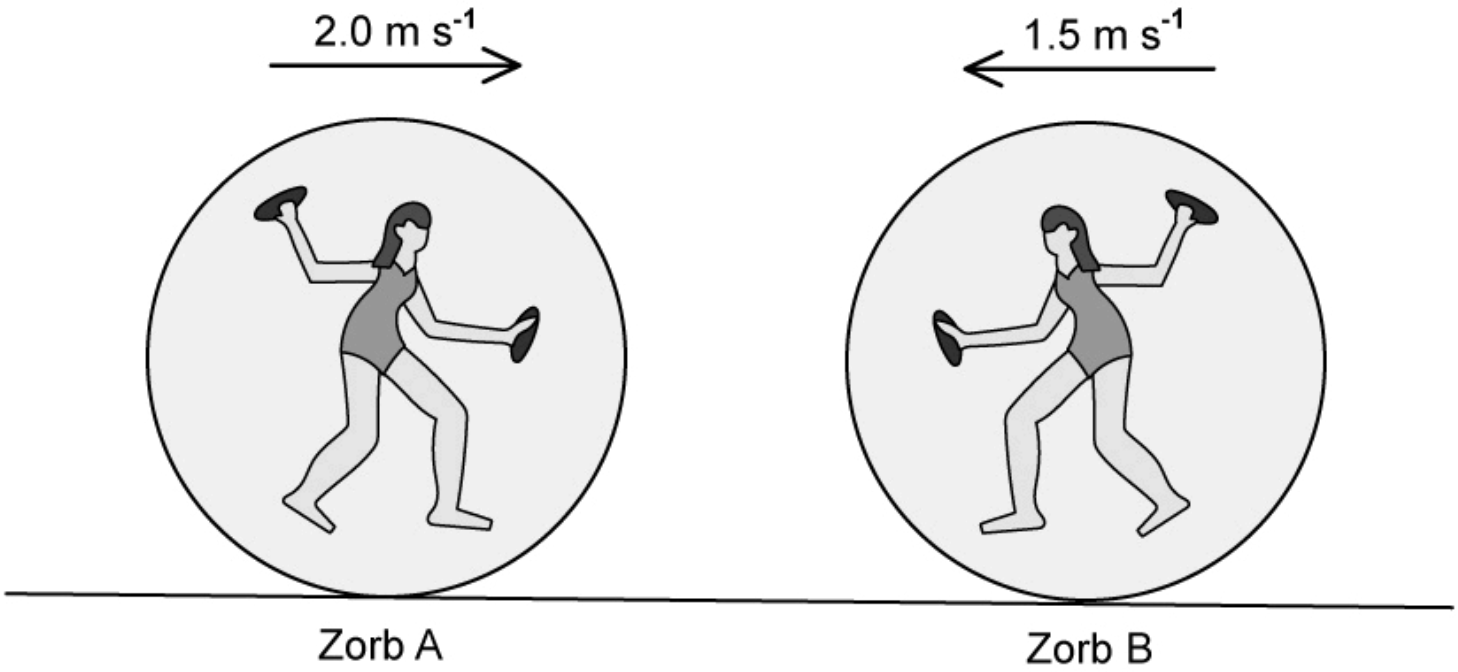
$$F = \frac{\Delta p}{\Delta t}$$

Calculate the average force needed to stop the bullet.

[4 marks]

Question 4a

Zorbing is an activity which involves a person running inside an inflatable ball, called a 'zorb'. Two zorbs, A and B, collide head on with each other, as shown. The total mass of zorb A and its occupant is 75 kg and the total mass of zorb B and its occupant is 60 kg. Before the collision, zorb A is travelling at 2.0 m s^{-1} and zorb B is travelling at 1.5 m s^{-1}.



Calculate:

(i) The momentum of zorb A before the collision

[2]

(ii) The momentum of zorb B before the collision

[2]

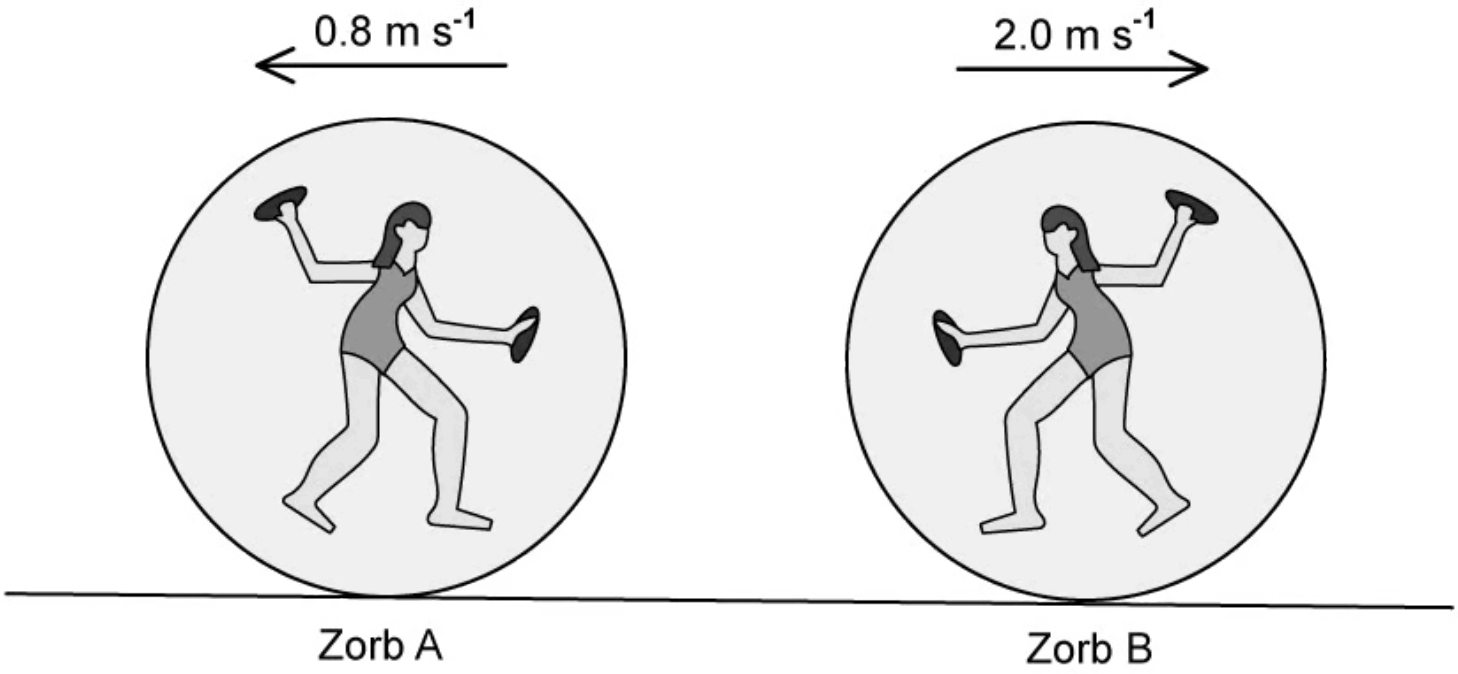
(iii) The total momentum of both zorbs before the collision

[2]

[6 marks]

Question 4b

After the collision, both zorbs bounce off each other and move in opposite directions, as shown below. Zorb A travels at 0.8 m s^{-1} and zorb B travels at 2.0 m s^{-1}.



Calculate:

(i) The momentum of zorb A after the collision

[2]

(ii) The momentum of zorb B after the collision

[2]

(iii) The total momentum of both zorbs after the collision

[2]

[6 marks]

Question 4c

Calculate:

(i) The total kinetic energy of the zorbs before the collision.

[2]

(ii) The total kinetic energy of the zorbs after the collision.

[2]

[4 marks]

Question 4d

State whether:

(i) Momentum is or is not conserved during the collision of the zorbs.

[1]

(ii) Kinetic energy is or is not conserved during the collision of the zorbs.

[1]

(iii) The collision of the zorbs is elastic or inelastic.

[1]

[3 marks]

Question 5a

A collision can be described as being elastic or inelastic. When there are no external forces acting on the collision.

Place a tick (✓) next to the quantities that are conserved in each type of collision,

Quantity	Elastic Collision	Inelastic Collision
Momentum		
Total Energy		
Kinetic Energy		

[3 marks]

Question 5b

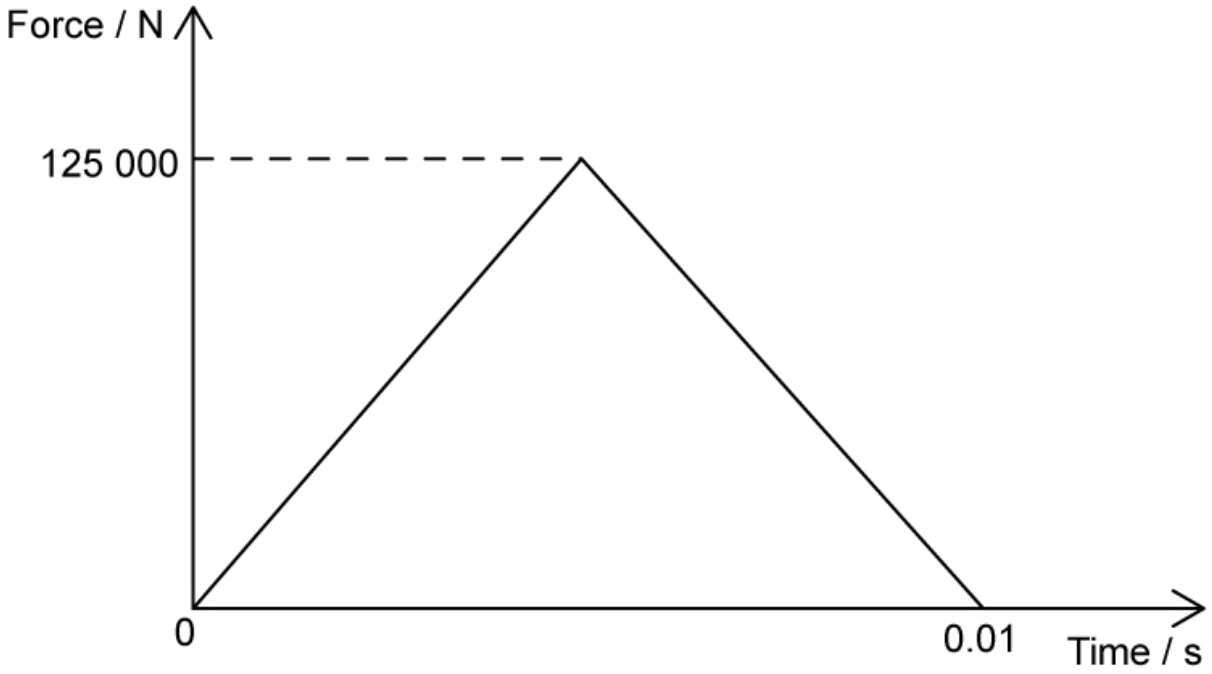
During a safety test, a car of mass 1250 kg travels at 0.5 m s^{-1} towards a wall.

Calculate the momentum of the car before it collides with the wall.

[2 marks]

Question 5c

The car has a force sensor attached to the bumper which detects the force exerted on the front of the car. The graph below shows the variation of force with time for the duration of the collision.



Use the graph to show that the impulse of the collision is 625 N s.

[3 marks]

Question 5d

All cars are designed with a crumple zone to protect passengers if they are involved in a collision.

State how a crumple zone:

(i) Affects the impact time of a collision.

[1]

(ii) Affects the force exerted on the car during a collision.

[1]

[2 marks]