

# Momentum in 1D

## Question Paper 3

<b>Level</b>	A Level
<b>Subject</b>	Maths
<b>Exam Board</b>	AQA
<b>Module</b>	Mechanics 1
<b>Topic</b>	Momentum
<b>Sub Topic</b>	Momentum in 1D
<b>Booklet</b>	Question Paper - 3

**Time Allowed:** 55 minutes

**Score:** /45

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

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**Q1.** Two particles,  $A$  and  $B$ , are travelling towards each other along a straight line. Both particles have a speed of  $5 \text{ m s}^{-1}$ . The mass of  $A$  is  $8 \text{ kg}$  and the mass of  $B$  is  $4 \text{ kg}$ .

(a) If  $A$  is brought to rest by the collision, find the speed of  $B$  after the collision.

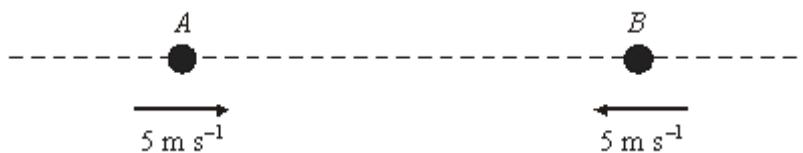
(4)

(b) If, after the collision, the speed of  $B$  is twice the speed of  $A$ , and both particles move in the same direction, find the speed of  $B$ .

(4)

(Total 8 marks)

**Q2.** Two particles,  $A$  and  $B$ , are moving towards each other along a straight horizontal line. They are both moving at  $5 \text{ m s}^{-1}$ . The mass of  $A$  is  $3 \text{ kg}$  and the mass of  $B$  is  $2 \text{ kg}$ . The particles collide.



(a) If the particles coalesce, find the speed of the combined particle after the collision.

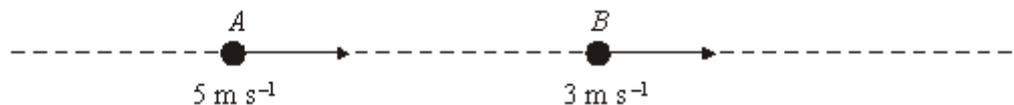
(3)

(b) If the particles do not coalesce during the collision, but the speed of particle  $A$  is reduced to  $0.5 \text{ m s}^{-1}$  and its direction of motion does not change, find the speed of particle  $B$  after the collision.

(4)

(Total 7 marks)

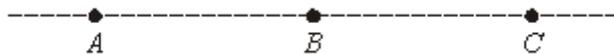
**Q3.** Two particles,  $A$  and  $B$ , are moving with constant speeds in the same direction along a straight horizontal line. The velocity of  $A$  is  $5 \text{ m s}^{-1}$  and its mass is  $0.1 \text{ kg}$ . The velocity of  $B$  is  $3 \text{ m s}^{-1}$  and its mass is  $0.4 \text{ kg}$ . The two particles collide. The diagram shows the velocities before the collision.



- (a) If the particles coalesce during the collision, find the velocity of the combined particle after the collision. (3)
- (b) If the particles do **not** coalesce during the collision, and the velocity of  $B$  increases to  $3.5 \text{ m s}^{-1}$ , find the velocity of  $A$  after the collision. (4)

(Total 7 marks)

- Q4.** Three particles,  $A$ ,  $B$  and  $C$ , are initially at rest in a straight line on a smooth horizontal surface. The masses of the particles are  $2 \text{ kg}$ ,  $4 \text{ kg}$  and  $m \text{ kg}$  respectively.



- (a) Particle  $A$  is set in motion with speed  $4 \text{ m s}^{-1}$  directly towards particle  $B$ . After colliding with  $B$ , particle  $A$  continues to move in the same direction but with speed  $1 \text{ m s}^{-1}$ . Find the speed of  $B$  after this collision. (3)
- (b) Particle  $B$  then collides with particle  $C$ . After this collision,  $C$  moves with a speed of  $2 \text{ m s}^{-1}$ . Find the speed of  $B$  after this collision, giving your answer in terms of  $m$ . (3)
- (c) If  $A$  collides with  $B$  again, show that  $m > 1$ . (4)

(Total 10 marks)

- Q5.** A child of mass  $25 \text{ kg}$  is sitting in a trolley of mass  $13 \text{ kg}$ . The trolley is initially at rest on a horizontal surface. A ball of mass  $2 \text{ kg}$  is thrown towards the child, who catches it.

The ball is travelling horizontally at  $5 \text{ m s}^{-1}$  just before it is caught. Assume that there is no resistance to the motion of the trolley.

- (a) Find the speed of the child and the trolley after the ball has been caught.

(2)

- (b) The child places the ball in the trolley. A second, identical ball is thrown, in the same direction as the first ball, and the child catches it. This ball is travelling horizontally at  $6 \text{ m s}^{-1}$  just before it is caught. Find the speed of the child and the trolley after the second ball has been caught.

(3)

(Total 5 marks)

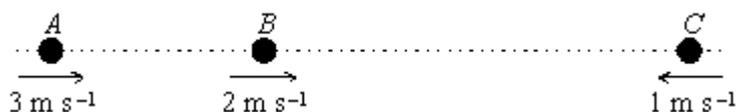
- Q6.** Three particles  $A$ ,  $B$  and  $C$  are set into motion along a straight line on a smooth horizontal surface.

$A$  has mass  $3 \text{ kg}$  and initially moves at  $3 \text{ m s}^{-1}$

$B$  has mass  $2 \text{ kg}$  and initially moves in the same direction as  $A$  at  $2 \text{ m s}^{-1}$

$C$  has mass  $5 \text{ kg}$  and initially moves in the opposite direction to  $A$  and  $B$  at  $1 \text{ m s}^{-1}$

The initial velocities and positions are shown in the diagram.



- (a) The particles  $A$  and  $B$  collide and join together. Show that the combined particle moves with a speed of  $2.6 \text{ m s}^{-1}$  after the collision.

(2)

- (b) When the combined particle collides with the particle  $C$ , they join together. Find the velocity of this new combined particle after this collision.

(3)

- (c) After the second collision a force acts on the new combined particle for  $0.2$  seconds and brings it to rest. Find the magnitude of this force.

(3)

(Total 8 marks)

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