

4.3 Momentum

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS momentum 动量 • conservation of momentum 动量守恒 • mass 质量 • speed 速率
• velocity 速度

Objective

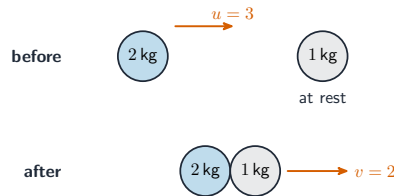
Build the skills to answer exam questions on **momentum** 动量 — linear momentum and the **conservation of momentum** 动量守恒 in collisions. Take $g = 10 \text{ m s}^{-2}$.

You must be able to:

- calculate momentum (mass $\times$ velocity), treating direction with signs
- apply $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
- handle “stick together” (coalesce) collisions

1 Worked examples

■ Conservation of momentum



$$2(3) + 1(0) = (2 + 1)v$$

Total momentum is the same before and after a collision

2 kg at 3 m s^{-1} hits a stationary 1 kg and they stick:

$$2(3) + 1(0) = (2 + 1)v \Rightarrow v = \frac{6}{3} = 2 \text{ m s}^{-1}.$$

Sign convention: choose a positive direction; a velocity the other way is negative.

2 Practice

2.1 Find the momentum of a 0.5 kg ball moving at 8 m s^{-1} . [1]

2.2 State what physical quantity is conserved in a collision with no external horizontal force. [1]

3 Exam-style questions

3.1 A 3 kg body at 4 m s^{-1} collides with a 2 kg body at rest and they coalesce. Their common speed is: [1]

- **A** 1.2 m s^{-1}
- **B** 2.0 m s^{-1}
- **C** 2.4 m s^{-1}
- **D** 4.0 m s^{-1}

3.2 A particle *A* of mass 0.4 kg moving at 5 m s^{-1} collides directly with particle *B* of mass 0.6 kg moving in the **opposite** direction at 2 m s^{-1} . After the collision they move together.

(a) Find their common velocity, stating its direction. [4]

3.3 A 2 kg ball moving at 6 m s^{-1} strikes a 4 kg ball at rest. After the collision the 2 kg ball continues in the same direction at 1 m s^{-1} . Find the speed of the 4 kg ball. [3]

Solutions

2.1 $p = mv = 0.5 \times 8 = 4 \text{ kg m s}^{-1}$.

2.2 (linear) momentum.

3.1 C. $3(4) = (3 + 2)v \Rightarrow v = \frac{12}{5} = 2.4 \text{ m s}^{-1}$.

3.2 take A 's direction positive: $0.4(5) + 0.6(-2) = (0.4 + 0.6)v$; $2 - 1.2 = 1.0v \Rightarrow v = 0.8$;
 0.8 m s^{-1} in A 's original direction.

3.3 $2(6) + 4(0) = 2(1) + 4v$; $12 = 2 + 4v \Rightarrow v = \frac{10}{4} = 2.5 \text{ m s}^{-1}$.