

Solutions

Each answer shows the steps, then the **result**.

2.1

- When no net external force acts on the system

2.2

- momentum is conserved; the carts move together afterwards:

$$m_1 u_1 = (m_1 + m_2)v \quad \Rightarrow \quad (4 \text{ kg})(2 \text{ m s}^{-1}) = (8 \text{ kg})v$$

- $v = \mathbf{1 \text{ m s}^{-1}}$

2.3

- Zero (equal and opposite momenta)

2.4

- 30 kg m s^{-1} (conserved)

3.1 B

- momentum is conserved when no net external force acts

3.2 B

- momentum is conserved and the balls move together:

$$m_1 u_1 = (m_1 + m_2)v \quad \Rightarrow \quad v = \frac{(3 \text{ kg})(4 \text{ m s}^{-1})}{4 \text{ kg}} = 3 \text{ m s}^{-1}$$

3.3

(a)

- Zero (both at rest)

(b)

- momentum is conserved, so the total stays zero:

$$0 = m_s v_s + m_b v_b \quad \Rightarrow \quad v_s = -\frac{m_b v_b}{m_s} = -\frac{(2 \text{ kg})(10 \text{ m s}^{-1})}{60 \text{ kg}}$$

- $v_s = -0.33 \text{ m s}^{-1}$: the skater recoils at **0.33** m s⁻¹, opposite to the ball

3.4

(a)

- only the moving trolley has momentum:

$$p = m_1 u_1 = (2 \text{ kg})(5 \text{ m s}^{-1}) = \mathbf{10 \text{ kg m s}^{-1}}$$

(b)

- momentum is conserved; the coupled trolleys share one velocity:

$$p = (m_1 + m_2)v \quad \Rightarrow \quad v = \frac{10 \text{ kg m s}^{-1}}{5 \text{ kg}}$$

- $v = \mathbf{2 \text{ m s}^{-1}}$