

How momentum is conserved in collisions

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Test answers (mark scheme)

Use this marking scheme to score yourself. Award marks for a correct formula, a correct substitution and a correct final answer with unit and direction. Do not give the final mark if the unit or the sign is missing.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS2-2, HS-PS2-3

Question 1 Momentum basics (2 marks)

- Momentum is mass multiplied by velocity ($p = mv$).
- The unit is **kg m/s**.

Marking: 1 mark for mass $\times$ velocity, 1 mark for the correct unit.

Question 2 Tennis ball (2 marks)

$p = mv = 0.058 \times 45 = 2.61$, so **2.6 kg m/s**.

Marking: 1 mark for the substitution, 1 mark for the answer with unit.

Question 3 Locking trolleys (3 marks)

Momentum before = $4.0 \times 3.0 = 12$ kg m/s. After: $6.0 \times v = 12$, so $v =$ **2.0 m/s**.

Marking: 1 mark for momentum before, 1 mark for equating to total mass $\times v$, 1 mark for the answer with unit.

Question 4 Rifle recoil (3 marks)

Bullet momentum = $0.020 \times 300 = 6.0$ kg m/s. The rifle has equal momentum backwards: $4.0 \times v = 6.0$, so $v =$ **1.5 m/s** backwards.

Marking: 1 mark for the bullet momentum, 1 mark for equal and opposite momentum, 1 mark for the answer with direction.

Question 5 Force on a trolley (3 marks)

- Impulse = $Ft = 30 \times 0.40 =$ **12 N s**.
- $\Delta p =$ **12 kg m/s**.
- $v = 12 \div 6.0 =$ **2.0 m/s**.

Marking: 1 mark for each part.

Question 6 Airbag (2 marks)

The driver's momentum must fall to zero, and the airbag makes this take a longer time. Since $F = \Delta p \div t$, the same Δp over a longer time gives a **smaller force**.

Marking: 1 mark for longer stopping time, 1 mark for using $F = \Delta p \div t$ to conclude the force is smaller.

Question 7 Opposite directions (3 marks)

- a. $2.0 \times 4.0 + 3.0 \times (-2.0) = 8.0 - 6.0 = \mathbf{+2.0 \text{ kg m/s}}$.
- b. $2.0 + 3.0 = \mathbf{5.0 \text{ kg}}$.
- c. $v = 2.0 \div 5.0 = \mathbf{0.40 \text{ m/s}}$ to the right.

Marking: 1 mark for each part; deduct the first mark if the minus sign is missing.

Question 8 Catching a ball (2 marks)

Pulling the hands back increases the time over which the ball stops. The change in momentum is fixed, so the average force on the hands is **smaller**, and the catch hurts less.

Marking: 1 mark for longer time, 1 mark for smaller force because Δp is fixed.