

Conservation of momentum and collisions

AS Level

9702 AS Ch. 6

Chapter 6: Momentum

Lesson 6.2

Sections 6.2

Goal: Use conservation of momentum to find an unknown velocity or mass after a collision.

 velocity

01 The big picture

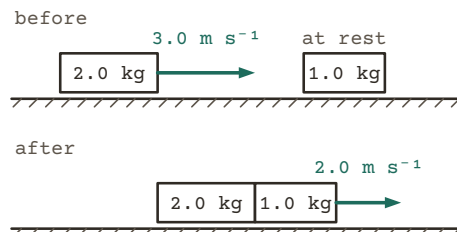
In a collision the objects push on each other with equal and opposite forces, so the momentum one gains the other loses. The total momentum of the system stays the same, provided no resultant external force acts on it.

Write total momentum before = total momentum after, with a sign for every velocity. If the objects stick together they move off with one shared velocity.

Principle of conservation of momentum [paraphrase]

The total momentum of a system stays constant, provided no resultant external force acts on it.

Fig. 1 · Two trolleys stick together



Momentum before: $2.0 \times 3.0 = 6.0 \text{ kg m s}^{-1}$. After: $3.0 \times 2.0 = 6.0 \text{ kg m s}^{-1}$.

02 Key equations

Conservation of momentum

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

They stick together

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$$

Symbols and units

m mass of each object kg u, v velocity before, after m s^{-1}

03 Sample problems with solutions

Sample 1 · Trolleys that stick

A 2.0 kg trolley moving at 3.0 m s^{-1} hits a stationary 1.0 kg trolley and they stick together (Fig. 1). Calculate their velocity just after the collision.

Step 1. Momentum before = momentum after:

$$2.0 \times 3.0 + 1.0 \times 0 = (2.0 + 1.0) v$$

Step 2. v is multiplied by 3.0; divide:

$$v = \frac{6.0}{3.0} = 2.0 \text{ m s}^{-1}$$

Answer: 2.0 m s^{-1} in the original direction

Unit check: $\frac{\text{kg m s}^{-1}}{\text{kg}} = \text{m s}^{-1} \checkmark$

04 Practice problems

P1 A 4.0 kg trolley at 5.0 m s^{-1} hits a stationary 1.0 kg trolley and they stick. Find their velocity.
Answer: 4.0 m s^{-1}

P2 A 0.50 kg ball at 6.0 m s^{-1} hits a stationary 1.5 kg block and rebounds at 1.5 m s^{-1} . Find the block's velocity.
Answer: 2.5 m s^{-1} forwards

P3 A 2.0 kg trolley at 4.0 m s^{-1} meets a 3.0 kg trolley moving at 2.0 m s^{-1} towards it. They stick. Find the velocity.
Answer: 0.40 m s^{-1} in the 2.0 kg trolley's direction

P4 When is the total momentum of a system conserved?
Answer: When no resultant external force acts on it

05 Other useful information

Common mistakes

- ✗ **Wrong:** Write the rebound velocity as positive.
- ✓ **Right:** Moving back is negative: $v = -1.5 \text{ m s}^{-1}$

Exam tips

- Sketch "before" and "after" with arrows and masses; then write one equation.

What the syllabus asks

- 9702 topic 3: state and apply the principle of conservation of momentum. Coursebook 6.2.

Explore: [Practice questions for this lesson](#)