

Momentum

A-Level Maths 9709 · Topic 4.3 revision notes

Everything from the 1 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Momentum and the conservation of momentum

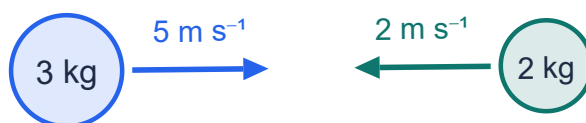
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1 Momentum and the conservation of momentum

Syllabus 4.3

Momentum = mv , measured in kg m s^{-1} (or N s), with a sign showing its direction. In a direct collision: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$. If the particles coalesce, $m_1u_1 + m_2u_2 = (m_1 + m_2)v$.

Before



After



+ →

$$3(5) + 2(-2) = 5v, \text{ so } v = 2.2$$

Fig. 1: two particles moving towards each other coalesce. With right as positive, the 2 kg particle has velocity -2 m s^{-1} , so the combined particle moves right at 2.2 m s^{-1}

Worked example: Change of momentum

A ball of mass 200 g hits a wall at 15 m s^{-1} and rebounds along the same line at 12 m s^{-1} . Find the change in its momentum.

1. Mass = 0.2 kg. Take the direction towards the wall as positive.
2. Before: $0.2 \times 15 = 3 \text{ N s}$. After: $0.2 \times (-12) = -2.4 \text{ N s}$.
3. Change = $-2.4 - 3 = -5.4 \text{ N s}$.

Answer: 5.4 N s, directed away from the wall.

Diagram, signs, one equation.

- ✓ **Diagram:** before and after, masses in kg, every velocity marked.
- ✓ **Positive direction:** velocities the other way are negative.
- ✓ **Conserve:** $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$; coalescing uses $(m_1 + m_2)v$.
- ✓ **Interpret:** a negative answer means the particle moves in the negative direction.
- ✓ **Chains:** one collision at a time, then check whether another collision occurs.

Watch out!

Subtracting the speeds gives $0.2(15 - 12) = 0.6 \text{ N s}$, which is wrong. The velocity changed sign, so the sizes ADD: $0.2(15 + 12) = 5.4 \text{ N s}$.

Every unknown velocity after the collision should be written as a signed variable, and the sign of the answer tells you the direction. A negative answer is not an error; it means the particle moves in the negative direction.

Do not do both collisions in one equation unless all the particles really do end up moving together. If A and B separate after the first collision, each must be tracked on its own.