

Objective

1 Key knowledge and worked examples

Worked example – the full algebra (WME02 June 2025 Q5a–c). P ($2m$, speed u) strikes Q (m , at rest): $2u = 2v_P + v_Q$ and $eu = v_Q - v_P$ give $v_Q = \frac{2(1+e)u}{3}$ and $v_P = \frac{(2-e)u}{3}$. KE after = $\frac{mu^2}{3}(2 + e^2)$, so the loss is $\frac{mu^2}{3}(1 - e^2)$ – the constant $k = \frac{1}{3}$. If the impulse on Q is $\frac{8mu}{9}$: $m \cdot \frac{2(1+e)u}{3} = \frac{8mu}{9}$ gives $e = \frac{1}{3}$.

2 Practice

2.1 A 3 kg particle at 4 m s^{-1} catches a 1 kg particle at 1 m s^{-1} , both moving right; they coalesce. Find the common speed and the energy lost. [4]

2.2 Two equal masses collide with $e = \frac{1}{2}$: A at 6 m s^{-1} hits B at rest. Find both speeds after. [3]

2.3 Using the loss formula $\text{loss} = \frac{m_A m_B}{2(m_A + m_B)}(1 - e^2)(u_A - u_B)^2$, show that a direct collision conserves total kinetic energy only if $e = 1$ or the particles already have equal velocities.[2]

3 Exam-style questions

3.1 (*Edexcel IAL WME02 June 2025 Q5a–c, condensed.*) Two particles P (mass $2m$) and Q (mass m) lie at rest on a smooth horizontal plane. P is projected with speed u directly towards Q, and they collide directly with coefficient of restitution e ($e > 0$). (a) Show that the speed of Q immediately after the collision is $\frac{2(1+e)u}{3}$. (b) Show that the total kinetic energy lost in the collision is $k(1 - e^2)mu^2$, where k is a constant to be determined. (c) Given that the magnitude of the impulse exerted on Q by P is $\frac{8}{9}mu$, find e . [12]

3.2 (*Original.*) A 2 kg particle moving right at 5 m s^{-1} collides directly with a 3 kg particle moving left at 1 m s^{-1} ; the coefficient of restitution is $\frac{1}{4}$. Find both velocities after the collision, and the total energy lost. [6]
