5.5 Successive impacts and wall rebounds

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS restitution • separation speed

Successive impacts and wall rebounds

Objective

Chain collisions: solve each impact completely, carry speeds into the next, handle rebounds from fixed walls (speed scaled by e, direction reversed), and equate only what the question ties together (objectives 4.1–4.3).

1 Key knowledge and worked examples

Chains. A fixed wall collision multiplies the speed by the wall's restitution and reverses direction – no momentum equation (the wall is immovable). Between two moving particles, momentum + restitution as usual. Work stage by stage with a signed diagram; "same speed" or "at rest" conditions close the algebra.

Worked example – matching a rebound (WME02 June 2025 Q5d). After the collision of Q5, Q moves at $\frac{2(1+e)u}{3}$ and P at $\frac{(2-e)u}{3}$ with $e = \frac{1}{3}$, so $v_Q = \frac{8}{9}u$ and $v_P = \frac{5}{9}u$. Q hits a wall with restitution f and rebounds matching P's speed: $f \cdot \frac{8}{9}u = \frac{5}{9}u$, so $f = \frac{5}{8}$.

2 Practice

2.1 A ball hits a smooth wall at 8 m s^{-1} perpendicularly with $e = 0.4$. Find its rebound speed. [1]

2.2 A 1 kg ball moving right at 6 m s^{-1} hits a wall ($e = \frac{1}{3}$) and rebounds into a stationary 2 kg ball, with which it collides with restitution $\frac{1}{2}$. Find the 2 kg ball's speed after. [5]

2.3 Three particles A, B, C in a line: A (m) at $3u$ hits B (m) at rest with $e = \frac{1}{2}$; B then hits C (2m) at rest with $e = \frac{1}{4}$. Find C's final speed. [6]

3 Exam-style questions

3.1 *(Edexcel IAL WME02 June 2025 Q5d.)* Following the collision of question 3.1 on the collisions sheet (masses $2m$ and m, restitution $e = \frac{1}{3}$): Q now moves towards a fixed vertical wall at right angles to its motion and rebounds with coefficient of restitution f. Given that immediately after the rebound Q has the same speed as P, find f. [3]

3.2 *(Original.)* Two balls P (1 kg) and Q (2 kg) lie in a line on a smooth floor between two parallel walls. P is projected at 12 $\mathrm{m\,s^{-1}}$ towards Q; they collide with $e = \frac{1}{2}$; Q then hits the far wall with $e = \frac{1}{3}$ and rebounds to collide with P again. Find the speeds of both balls after the second P–Q collision, given it has restitution $\frac{1}{3}$. [8]