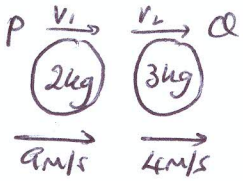
2007 HL

5. (a) A smooth sphere P, of mass 2 kg, moving with speed 9 m/s collides directly with a smooth sphere Q, of mass 3 kg, moving in the same direction with speed 4 m/s.
The coefficient of restitution between the spheres is e.

(i) Find, in terms of e, the speed of each sphere after the collision.

(ii) Show that the magnitude of the momentum transferred from one sphere to the other is $6(1+e)$.



Before	Mass	After
$u_1 = 9$	2kg	v_1
$u_2 = 4$	3kg	v_2

(*i*) PCM $\quad 2(9) + 3(4) = 2v_1 + 3v_2$ ① — 5

NEL $\quad v_1 - v_2 = -e(9-4)$ ② — 5

① $2v_1 + 3v_2 = 30$
$3 \times$ ② $3v_1 - 3v_2 = -15e$
$5v_1 = 30 - 15e$
$v_1 = 6 - 3e$
Sub into ②
$6 - 3e + 5e = v_2$
$6 + 2e = v_2$

$v_1 = \dfrac{30-15e}{5}$ or $6-3e$

$v_2 = \dfrac{30+10e}{5}$ or $6+2e$ — 5

Momentum transferred = Impulse. $\quad m_1u_1 - m_1v_1$

(*ii*) Impulse $= 2(9) - 2(6-3e)$
$= 6 + 6e$
$= 6(1+e)$ — 5

OR

$m_2u_2 - m_2v_2$

Impulse $= 3(4) - 3(6+2e)$
$= -6 - 6e$
$= -6(1+e)$

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