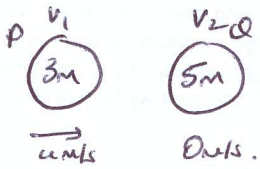
2004 HL

5. **(a)** A smooth sphere P, of mass $3m$, moving with speed u, collides directly with a smooth sphere Q, of mass $5m$, which is at rest.
The coefficient of restitution for the collision is e.

Find

(i) the speed, in terms of u and e, of each sphere after the collision

(ii) the condition to be satisified by e in order that the spheres move in opposite directions after the collision.



(i) PCM $\quad 3m(u)+5m(0) = 3mv_1 + 5mv_2$ ①

NEL $\quad v_1 - v_2 = -e(u-0)$ ②

$$v_1 = \frac{u}{8}(3-5e)$$

$$v_2 = \frac{3u}{8}(1+e)$$

If spheres are to move in opposite directions then P moves left $\Rightarrow v_1 < 0$ & Q right $\Rightarrow v_2 > 0$,

But $v_2 > 0$ since $e > 0$.

$\Rightarrow v_1 < 0$

$\frac{u}{8}(3-5e) < 0 \quad (\times \frac{8}{u})$

$\Rightarrow 3-5e < 0$

$\Rightarrow \frac{3}{5} < e$

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