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

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

   (ii) Prove that the speed of Q increases after the collision.

   (iii) Find the value of e if the speed of P after the collision is $\dfrac{10u}{9}$ m/s.

(i) PCM $\quad m(2u) + 2m(u) = mv_1 + 2mv_2$ $\qquad$ 5

$\quad$ NEL $\qquad v_1 - v_2 = -e(2u - u)$ $\qquad$ 5

$$v_1 = \frac{u(4 - 2e)}{3}$$ $\qquad$ 5

$$v_2 = \frac{u(4 + e)}{3}$$ $\qquad$ 5

(ii) $\qquad v_2 = \frac{u(4 + e)}{3}$

$\qquad > u$ as $e > 0$

$\qquad \Rightarrow$ speed of Q increases $\qquad$ 5

(iii) $\qquad v_1 = \frac{u(4 - 2e)}{3}$

$$\frac{10u}{9} = \frac{u(4 - 2e)}{3}$$

$\qquad \Rightarrow e = \frac{1}{3}$ $\qquad$ 5 $\qquad$ 30