5. **(a)** A sphere, of mass m and speed u, impinges directly on a stationary sphere of mass $3m$.

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The coefficient of restitution between the spheres is e.

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

(ii) If $e = \frac{1}{4}$, find the percentage loss in kinetic energy due to the collision.

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

NEL $\quad v_1 - v_2 = -e(u-0)$ $\quad$ 5

$$v_1 = \frac{u(1-3e)}{4}$$
$$v_2 = \frac{u(1+e)}{4}$$ $\quad$ 5

(*ii*) $\quad e = \frac{1}{4}$

$\Rightarrow v_1 = \frac{u}{16}$ and $v_2 = \frac{5u}{16}$

K.E. before $= \frac{1}{2}mu^2$

K.E. after $= \frac{1}{2}mv_1^2 + \frac{1}{2}(3m)v_2^2$

$$= \frac{1}{2}m\left(\frac{u}{16}\right)^2 + \frac{1}{2}(3m)\left(\frac{5u}{16}\right)^2$$

$$= \frac{76mu^2}{512} \quad \text{or} \quad \frac{19mu^2}{128}$$

Loss in KE $= \frac{1}{2}mu^2 - \frac{19mu^2}{128} = \frac{45mu^2}{128}$ $\quad$ 5

Percentage loss in KE $= \frac{\frac{45mu^2}{128}}{\frac{1}{2}mu^2}(100) = 70.3\,\%$ $\quad$ 5 $\quad$ 25