2008

5. **(a)** Three identical smooth spheres lie at rest on a smooth horizontal table with their centres in a straight line. The first sphere is given a speed 2 m/s and it collides directly with the second sphere. The second sphere then collides directly with the third sphere.
The coefficient of restitution for each collision is e, where $e < 1$.

(i) Find, in terms of e, the speed of each sphere after two collisions have taken place.

(ii) Show that there will be at least one more collision.

(*i*) PCM $\quad m(2) + m(0) = mv_1 + mv_2$ — 5

NEL $\quad v_1 - v_2 = -e(2-0)$

$v_1 = 1-e$ and $v_2 = 1+e$ — 5

PCM $\quad m(1+e) + m(0) = mv_3 + mv_4$ — 5

NEL $\quad v_3 - v_4 = -e(1+e)$

$v_3 = \frac{1}{2}(1-e^2)$ and $v_4 = \frac{1}{2}(1+e)^2$ — 5

speeds after 2nd impact : $1-e, \frac{1}{2}(1-e^2), \frac{1}{2}(1+e)^2$

(*ii*) First sphere will collide : again with second sphere if

$$1-e > \tfrac{1}{2}(1-e^2)$$

$$1-e > \tfrac{1}{2} - \tfrac{1}{2}e^2$$

$$e^2 - 2e + 1 > 0$$

$$(e-1)^2 > 0$$

This is true for $e < 1$ — 5

25