2001 HL

5. **(a)** A uniform smooth sphere of mass 2 kg and moving with speed u m/s collides with another smooth sphere of mass 3 kg which is at rest. The velocity of the sphere of mass 2 kg before impact makes an angle of 45° with the line of centres at impact. The coefficient of restitution between the spheres is e.

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

(ii) If the sphere of mass 2 kg makes an angle $\tan^{-1} 10$ with the line of centres after impact, find e.

PCM $\quad 2\left(\frac{u}{\sqrt{2}}\right) + 3(0) = 2v_1 + 3v_2$ — 5

NEL $\quad v_1 - v_2 = -e\left(\frac{u}{\sqrt{2}}\right)$ — 5

$\Rightarrow \quad v_1 = \frac{u}{5\sqrt{2}}(2-3e) \quad$ and $\quad v_2 = \frac{u}{5\sqrt{2}}(2+2e)$ — 5

Speed of first sphere $= \sqrt{\left\{\frac{u}{5\sqrt{2}}(2-3e)\right\}^2 + \left\{\frac{u}{\sqrt{2}}\right\}^2}$

Speed of second sphere $= \frac{u}{5\sqrt{2}}(2+2e)$

$10 = \dfrac{\frac{u}{\sqrt{2}}}{\frac{u}{5\sqrt{2}}(2-3e)}$ or $10 = \dfrac{\frac{u}{\sqrt{2}}}{-\frac{u}{5\sqrt{2}}(2-3e)}$ — 5

$\Rightarrow \quad e = \frac{1}{2}$ or $e = \frac{5}{6}$ — 5

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