

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  $45^\circ$  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  $e$ .

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

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

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

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

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

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

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

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