ASSIGNMENT 9

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1 QUESTION No 2.23

Consider the collision depicted in below fig 1.1 to be between two billiard balls with equal masses $m_1 = m_2$. The first ball is called the cue while second ball is called the target. The billiards player wants to sink the target ball in corner pocket, which is at an angle $\theta_2 = 37°$. Assume that the collision is elastic and frictional, rotational motions are not important. Obtain θ_1.
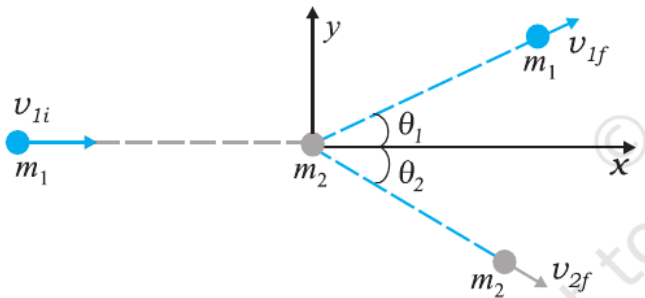

Fig. 1.1: Collision of two billiard balls

2 SOLUTION

Because, the target ball initially at rest conversation of energy gives,

$$\frac{1}{2}m_1v_{1i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2 \qquad (2.0.1)$$

$$\implies v_{1i}^2 = v_{1f}^2 + v_{2f}^2 \quad (\because m_1 = m_2) \qquad (2.0.2)$$

Applying conversation of momentum to two dimensional collision gives,

$$v_{1i} = v_{1f} + v_{2f} \quad (\because m_1 = m_2) \qquad (2.0.3)$$

$$\implies v_{1i}^2 = v_{1f}^2 + v_{2f}^2 + 2v_{1f}.v_{2f}\cos(\theta_1 + \theta_2) \qquad (2.0.4)$$

Subtracting (2.0.2) from (2.0.4)

$$\cos(\theta_1 + \theta_2) = 0 \qquad (2.0.5)$$

$$\implies \cos(\theta_1 + \theta_2) = \cos 90° \qquad (2.0.6)$$

$$\implies \theta_1 + \theta_2 = 90° \qquad (2.0.7)$$

$$\implies \theta_1 + 37° = 90° \quad (\because \theta_2 = 37°) \qquad (2.0.8)$$

$$\implies \theta_1 = 53° \qquad (2.0.9)$$

$\therefore$ Above result shows that whenever two equal masses undergo a glancing elastic collision and one of them is initially at rest they move at right angles to each other.