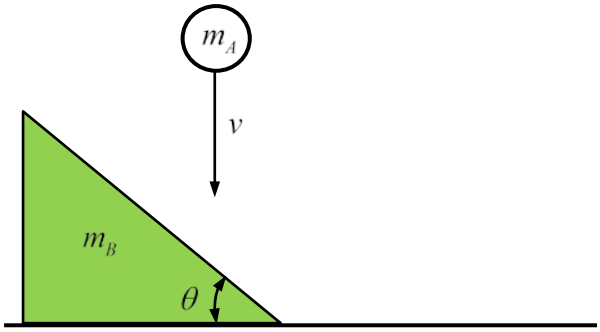
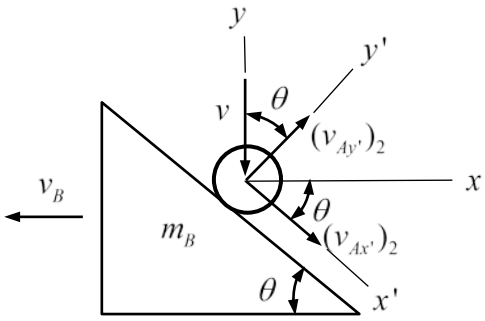
2-29. A steel ball strikes a block with a vertical velocity $v \sim N(50, 5^2)$ m/s. The masses of the ball and block are $m_A = 0.1$ kg and $m_B = 10$ kg, respectively. Assume the floor is smooth, $\theta = 45^\circ$, and the coefficient of restitution is $e = 0.8$, determine the velocity of the block just after the collision.





Conservation of momentum in x'-axis:

$$m_A(v_A)_1 = m_A(v_A)_2$$

$$(\searrow +)\ m_A v \sin\theta = m_A(v_{Ax'})_2$$

$$(v_{Ax'})_2 = v\sin\theta$$

Coefficient of restitution in y'-axis:

$$e = \frac{(v_{By'})_2 - (v_{Ay'})_2}{(v_{Ay'})_1 - (v_{By'})_1}$$

$$(+\swarrow)\ e = \frac{v_B\cos\theta - [-(v_{Ay'})_2]}{v\cos\theta - 0}$$

$$(v_{Ay'})_2 = ev\cos\theta - v_B\cos\theta$$

Conservation of momentum in x-axis:

$$0 = m_A(v_A)_x + m_B v_B$$

$$0 + 0 = m_A(v_{Ax'})_2 \cos\theta + m_A(v_{Ay'})_2 \cos\theta - m_B v_B$$

$$m_A v \sin\theta \cos\theta + m_A e v(\cos\theta)^2 - m_A v_B(\cos\theta)^2 - m_B v_B = 0$$

$$v_B = \frac{m_A \cos\theta(\sin\theta + e\cos\theta)v}{m_B + m_A(\cos\theta)^2}$$

$$\mu_{v_B} = \frac{m_A \cos\theta(\sin\theta + e\cos\theta)\mu_v}{m_B + m_A(\cos\theta)^2} = \frac{0.1(\cos 45^\circ)(\sin 45^\circ + 0.8\cos 45^\circ)(50)}{10 + 0.1(\cos 45^\circ)^2} = 0.45 \text{ m/s}$$

$$\sigma_{v_B} = \frac{m_A \cos\theta(\sin\theta + e\cos\theta)\sigma_v}{m_B + m_A(\cos\theta)^2} = \frac{0.1(\cos 45^\circ)(\sin 45^\circ + 0.8\cos 45^\circ)(5)}{10 + 0.1(\cos 45^\circ)^2} = 0.05 \text{ m/s}$$

Therefore, $v_B \sim N(0.45, 0.05^2)$ m/s .