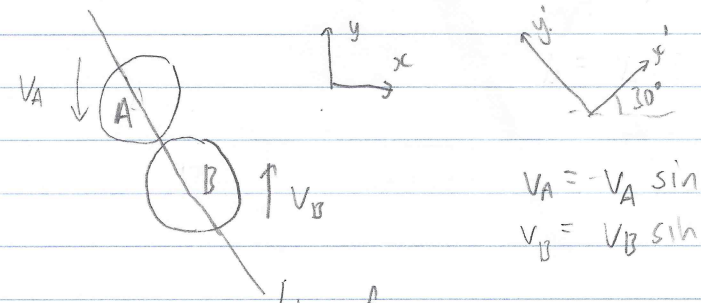
20-P-MOM-DY-16

Two disks, A and B, collide on a frictionless surface. A and B have a mass of $m_A = 5\,kg$ and $m_B = 10\,kg$ and velocity $v_A = -3\,\frac{m}{s}\,\hat{j}$ and $v_B = 2\,\frac{m}{s}\,\hat{j}$ respectively. The line of impact can be thought of as a line angled $\theta = 60°$ below the x-axis. Determine the final velocities of A & B (↳ speeds) if the coefficient of restitution $e = 0.7$.



$$v_A = -v_A \sin 30°\,\hat{i}' + v_A \cos 30°\,\hat{j}'$$
$$v_B = v_B \sin 30°\,\hat{i}' + v_B \cos 30°\,\hat{j}'$$

$$e = \frac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1} \quad \text{in } y' \text{ direction}$$

$$e(v_A - v_B)\cos 30° = (v_B)_2 - (v_A)_2 \qquad (v_B)_2 = (v_A)_2 + e(v_A - v_B)\cos 30°$$

conservation of momentum in y'

$$m_A(-v_A \cos 30°) + m_B(v_B \cos 30°) = m_A(v_A)_2 + m_B(v_B)_2$$
$$m_A(-v_A \cos 30°) + m_B(v_B \cos 30°) = m_A(v_A)_2 + m_B((v_A)_2 + e(v_A - v_B)\cos 30°)$$
$$\frac{m_A(-v_A \cos 30°) + m_B(v_B \cos 30°) - e m_B (v_A - v_B)\cos 30°}{m_A + m_B} = (v_A)_2$$

$$(v_A)_2\,\hat{j}' = 2.309\,\frac{m}{s}$$
$$(v_B)_2\,\hat{j}' = -0.722\,\frac{m}{s}$$

in x' direction, velocity is conserved

$$(v_A)_1\,\hat{i}' = (v_A)_2\,\hat{i}' = -v_A \sin 30° = -1.5\,\frac{m}{s}\,\hat{i}'$$

$$(v_B)_1\,\hat{i}' = (v_B)_2\,\hat{i}' = v_B \sin 30° = 1\,\frac{m}{s}\,\hat{i}'$$

$v_A = 2.75\,\frac{m}{s}$ 33° cw of y'

$v_B = 1.22\,\frac{m}{s}$ -35.8° ccw of x'