① $\Sigma \vec{p}_i = \Sigma \vec{p}_f \qquad m_A \vec{v}_{iA} + m_B \vec{v}_{iB} = m_A \vec{v}_{fA} + m_B \vec{v}_{fB}$

$$\vec{v}_{fB} = \frac{m_A}{m_B}(\vec{v}_{iA} - \vec{v}_{fA}) + \vec{v}_{iB} = \frac{2}{3}(\langle 15, 30\rangle - \langle -6, 30\rangle) + \langle -10, 5\rangle$$

$$= \langle 14, 0\rangle + \langle -10, 5\rangle = \langle 4, 5\rangle \text{ m/s}$$

$$K_i = \frac{1}{2} m_A v_{iA}^2 + \frac{1}{2} m_B v_{iB}^2 = \frac{1}{2}(2\text{kg})(15^2 + 30^2)\frac{\text{m}^2}{\text{s}^2} + \frac{1}{2}(3\text{kg})(10^2 + 5^2)\frac{\text{m}^2}{\text{s}^2}$$

$$= 1312.5 \text{ J}$$

$$K_f = \frac{1}{2} m_A v_{fA}^2 + \frac{1}{2} m_B v_{fB}^2 = \frac{1}{2}(2\text{kg})(6^2 + 30^2)\frac{\text{m}^2}{\text{s}^2} + \frac{1}{2}(3\text{kg})(4^2 + 5^2)\frac{\text{m}^2}{\text{s}^2}$$

$$= 997.5 \text{ J}$$

$$\Delta K = K_f - K_i = -315 \text{ J}$$

② Conserv. of momentum (x) $m_{He} v_{He,i} = m_{He} v_{He,f} \cos\theta_{He} + m_O v_{O,f} \cos\theta_O$

(y) $0 = m_{He} v_{He,f} \sin\theta_{He} + m_O v_{O,f} \sin\theta_O$

(a) From the y equation: $v_{O,f} = \dfrac{-m_{He} v_{He,f} \sin\theta_{He}}{m_O \sin\theta_O} = \dfrac{-(6.6465\times10^{-27}\text{kg})(6.636\times10^6 \frac{\text{m}}{\text{s}})\sin 84.7^\circ}{(2.6560\times10^{-26}\text{kg})\sin(-40.4^\circ)}$

$$= 2.551\times10^6 \text{ m/s}$$

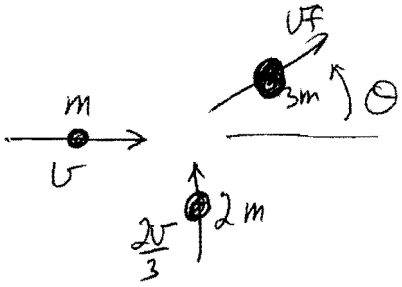
(b) From the x equation:

$$v_{He,i} = v_{He,f}\cos\theta_{He} + \frac{m_O}{m_{He}} v_{O,f}\cos\theta_O$$

$$= (6.636\times10^6 \tfrac{\text{m}}{\text{s}})\cos 84.7^\circ + \frac{2.6560\times10^{-26}\text{kg}}{6.6465\times10^{-27}\text{kg}}(2.551\times10^6 \tfrac{\text{m}}{\text{s}})\cos(-40.4^\circ)$$

$$= 8.376\times10^6 \text{ m/s}$$

(3)



Conservation of momentum (x) $mv = (3m) v_f \cos\theta$

(y) $(2m)\left(\frac{2v}{3}\right) = (3m) v_f \sin\theta$

$$\cos\theta = \frac{v}{3v_f} \qquad \sin\theta = \frac{4v}{9v_f}$$

$$\cos^2\theta + \sin^2\theta = \frac{v^2}{9v_f^2} + \frac{16v^2}{81v_f^2} = 1$$

$$25v^2 = 81 v_f^2 \quad \text{or} \quad v_f = 5/9\, v$$

$$\cos\theta = \frac{v}{3v_f} = \frac{v}{3(5v/9)} = \frac{3}{5} \qquad \theta = 53.1^\circ$$

$$K_i = \frac{1}{2}mv^2 + \frac{1}{2}(2m)\left(\frac{2v}{3}\right)^2 = \frac{1}{2}mv^2\left(1 + 2\cdot\frac{4}{9}\right) = \frac{1}{2}mv^2\left(\frac{17}{9}\right)$$

$$K_f = \frac{1}{2}(3m)\left(\frac{5}{9}v\right)^2 = \frac{1}{2}mv^2\left(\frac{25}{27}\right)$$

$$\frac{\Delta K}{K_i} = \frac{K_f - K_i}{K_i} = \frac{\frac{1}{2}mv^2\left(\frac{25}{27}\right) - \frac{1}{2}mv^2\left(\frac{17}{9}\right)}{\frac{1}{2}mv^2\left(\frac{17}{9}\right)} = -51\%$$