

34. Our  $+x$  direction is east and  $+y$  direction is north. The linear momenta for the two  $m = 2.0$  kg parts are then

$$\vec{p}_1 = m\vec{v}_1 = mv_1\hat{j}$$

where  $v_1 = 3.0$  m/s, and

$$\vec{p}_2 = m\vec{v}_2 = m(v_{2x}\hat{i} + v_{2y}\hat{j}) = mv_2(\cos\theta\hat{i} + \sin\theta\hat{j})$$

where  $v_2 = 5.0$  m/s and  $\theta = 30^\circ$ . The combined linear momentum of both parts is then

$$\begin{aligned}\vec{P} &= \vec{p}_1 + \vec{p}_2 \\ &= mv_1\hat{j} + mv_2(\cos\theta\hat{i} + \sin\theta\hat{j}) = (mv_2\cos\theta)\hat{i} + (mv_1 + mv_2\sin\theta)\hat{j} \\ &= (2.0\text{ kg})(5.0\text{ m/s})(\cos 30^\circ)\hat{i} + (2.0\text{ kg})(3.0\text{ m/s} + (5.0\text{ m/s})(\sin 30^\circ))\hat{j} \\ &= (8.66\hat{i} + 11\hat{j})\text{ kg}\cdot\text{m/s}.\end{aligned}$$

From conservation of linear momentum we know that this is also the linear momentum of the whole kit before it splits. Thus the speed of the 4.0-kg kit is

$$v = \frac{P}{M} = \frac{\sqrt{P_x^2 + P_y^2}}{M} = \frac{\sqrt{(8.66\text{ kg}\cdot\text{m/s})^2 + (11\text{ kg}\cdot\text{m/s})^2}}{4.0\text{ kg}} = 3.5\text{ m/s}.$$