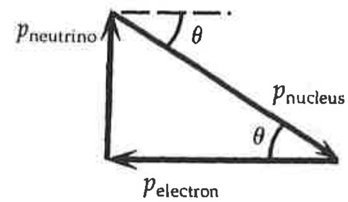
2-D Collisions

37. Because the initial momentum is zero, the momenta of the three products of the decay must add to zero. If we draw the vector diagram, we see that

$p_{nucleus} = (p_{electron}^2 + p_{neutrino}^2)^{1/2}$
$= [(9.30 \times 10^{-23}\ kg \cdot m/s)^2 + (5.40 \times 10^{-23}\ kg \cdot m/s)^2]^{1/2}$
$= \boxed{1.08 \times 10^{-22}\ kg \cdot m/s.}$

We find the angle from

$\tan\theta = p_{neutrino}/p_{electron}$
$= (5.40 \times 10^{-23}\ kg \cdot m/s)/(9.30 \times 10^{-23}\ kg \cdot m/s)$
$= 0.581$, so the angle is $\boxed{30.1° \text{ from the direction opposite to the electron's.}}$



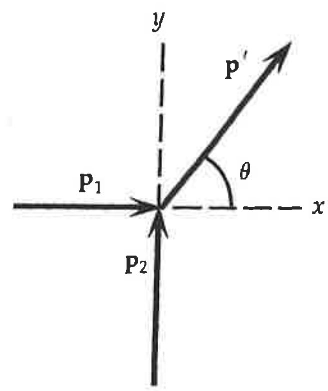
38. For the collision we use momentum conservation:

x-direction: $m_1v_1 + 0 = (m_1 + m_2)v' \cos\theta$;
$(4.3\ kg)(7.8\ m/s) = (4.3\ kg + 5.6\ kg)v' \cos\theta$, which gives
$v' \cos\theta = 3.39\ m/s$.

y-direction: $0 + m_2v_2 = (m_1 + m_2)v' \sin\theta$;
$(5.6\ kg)(10.2\ m/s) = (4.3\ kg + 5.6\ kg)v' \sin\theta$, which gives
$v' \sin\theta = 5.77\ m/s$.

We find the direction by dividing the equations:
$\tan\theta = (5.77\ m/s)/(3.39\ m/s) = 1.70$, so $\theta = \boxed{60°.}$

We find the magnitude by squaring and adding the equations:
$v' = [(5.77\ m/s)^2 + (3.39\ m/s)^2]^{1/2} = \boxed{6.7\ m/s.}$



39. (*a*) Using the coordinate system shown, for momentum conservation we have

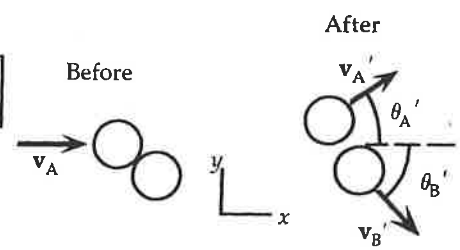
$$\boxed{\begin{array}{l} x\text{-momentum: } m_Av_A + 0 = m_Av_A' \cos\theta_A' + m_Bv_B' \cos\theta_B'; \\ y\text{-momentum: } 0 + 0 = m_Av_A' \sin\theta_A' - m_Bv_B' \sin\theta_B'. \end{array}}$$

(*b*) With the given data, we have

x: $(0.400\ kg)(1.80\ m/s) =$
$(0.400\ kg)(1.10\ m/s) \cos 30° + (0.500\ kg)v_B' \cos\theta_B'$,
which gives $v_B' \cos\theta_B' = 0.678\ m/s$;
y: $0 = (0.400\ kg)(1.10\ m/s) \sin 30° - (0.500\ kg)v_B' \sin\theta_B'$,
which gives $v_B' \sin\theta_B' = 0.440\ m/s$.

We find the magnitude by squaring and adding the equations:
$v_B' = [(0.440\ m/s)^2 + (0.678\ m/s)^2]^{1/2} = \boxed{0.808\ m/s.}$

We find the direction by dividing the equations:
$\tan\theta_B' = (0.440\ m/s)/(0.678\ m/s) = 0.649$, so $\theta_B = \boxed{33.0°.}$



41. Using the coordinate system shown, for momentum conservation we have

y-momentum: $-mv \sin\theta_1 + mv \sin\theta_2 = 0$, or $\theta_1 = \theta_2$.
x-momentum: $mv \cos\theta_1 + mv \cos\theta_2 = 2mv_2'$;
$2mv \cos\theta_1 = 2mv/3$;
$\cos\theta_1 = \frac{1}{3}$, or $\theta_1 = 70.5° = \theta_2$.

The angle between their initial directions is
$\phi = \theta_1 + \theta_2 = 2(70.5°) = \boxed{141°.}$