PHY 2130 Homework solutions
Assignment 6

6.5 (a) If $p_{ball} = p_{bullet}$,

then $v_{ball} = \dfrac{m_{bullet} v_{bullet}}{m_{ball}} = \dfrac{\left(3.00 \times 10^{-3}\text{ kg}\right)\left(1.50 \times 10^{3}\text{ m/s}\right)}{0.145\text{ kg}} = \boxed{31.0\text{ m/s}}$.

(b) The kinetic energy of the bullet is

$$KE_{bullet} = \frac{1}{2} m_{bullet} v_{bullet}^2 = \frac{\left(3.00 \times 10^{-3}\text{ kg}\right)\left(1.50 \times 10^{3}\text{ m/s}\right)^2}{2} = 3.38 \times 10^{3}\text{ J}$$

while that of the baseball is $KE_{ball} = \dfrac{1}{2} m_{ball} v_{ball}^2 = \dfrac{\left(0.145\text{ kg}\right)\left(31.0\text{ m/s}\right)^2}{2} = 69.7\text{ J}$.

The $\boxed{\text{bullet has the larger kinetic energy}}$ by a factor of 48.4.

6.16 Choose the positive direction to be from the pitcher toward home plate.

(a) $Impulse = \overline{F}(\Delta t) = \Delta p = m\left(v_f - v_i\right) = \left(0.15\text{ kg}\right)\left[\left(-22\text{ m/s}\right) - \left(20\text{ m/s}\right)\right]$

$Impulse = \overline{F}(\Delta t) = -6.3\text{ kg}\cdot\text{m/s}$, or $\boxed{6.3\text{ kg}\cdot\text{m/s toward the pitcher}}$

(b) $\overline{F} = \dfrac{Impulse}{\Delta t} = \dfrac{-6.3\text{ kg}\cdot\text{m/s}}{2.0 \times 10^{-3}\text{ s}} = -3.2 \times 10^{3}\text{ N}$,

or $\overline{F} = \boxed{3.2 \times 10^{3}\text{ N toward the pitcher}}$

6.22 Consider the thrower first, with velocity after the throw of $v_{thrower}$. Applying conservation of momentum yields

$$(65.0\text{ kg})v_{thrower}+(0.0450\text{ kg})(30.0\text{ m/s})=(65.0\text{ kg}+0.0450\text{ kg})(2.50\text{ m/s}),$$

or $$v_{thrower}=\boxed{2.48\text{ m/s}}.$$

Now, consider the (catcher + ball), with velocity of $v_{catcher}$ after the catch. From momentum conservation,

$$(60.0\text{ kg}+0.0450\text{ kg})v_{catcher}=(0.0450\text{ kg})(30.0\text{ m/s})+(60.0\text{ kg})(0),$$

or $$v_{catcher}=\boxed{2.25\times10^{-2}\text{ m/s}}.$$

6.36 Using conservation of momentum gives

$$(10.0\text{ g})v_{1f}+(15.0\text{ g})v_{2f}=(10.0\text{ g})(20.0\text{ cm/s})+(15.0\text{ g})(-30.0\text{ cm/s}) \quad (1)$$

For elastic, head on collisions, $v_{1i}+v_{1f}=v_{2i}+v_{2f}$ which becomes

$$20.0\text{ cm/s}+v_{1f}=-30.0\text{ cm/s}+v_{2f}. \quad (2)$$

Solving (1) and (2) simultaneously gives $v_{1f}=\boxed{-40.0\text{ cm/s}}$,

and $v_{2f}=\boxed{10.0\text{ cm/s}}$.

6.41 Choose the +*x*-axis to be eastward and the +*y*-axis northward.

(a) First, we conserve momentum in the *x* direction to find

$$(185\text{ kg})V\cos\theta=(90\text{ kg})(5.0\text{ m/s}),\text{ or }V\cos\theta=\left(\frac{90}{185}\right)(5.0\text{ m/s}) \quad (1)$$

Conservation of momentum in the *y* direction gives

$$(185\text{ kg})V\sin\theta=(95\text{ kg})(3.0\text{ m/s}),\text{ or }V\sin\theta=\left(\frac{95}{185}\right)(3.0\text{ m/s}) \quad (2)$$

Divide equation (2) by (1) to obtain $\tan\theta=\frac{(95)(3.0)}{(90)(5.0)}$, and □ = $\boxed{32°}$

Then, either (1) or (2) gives $V=2.88\text{ m/s}$, which rounds to $V=\boxed{2.9\text{ m/s}}$.

(b) $KE_{lost} = KE_i - KE_f$

$$= \frac{1}{2}\left[(90\text{ kg})(5.0\text{ m/s})^2 + (95\text{ kg})(3.0\text{ m/s})^2 - (185\text{ kg})(2.88\text{ m/s})^2\right]$$

$$= \boxed{7.9 \times 10^2\text{ J}}\text{ converted into internal energy}$$