C2) Paper is not a rigid object; so doesn't shatter. Also, it is not bounded by a frame, so it blows away.

C7.) No, it is not violated. You have to transfer energy to the ground; however, the change in velocity of the earth is so small it is not noticed.

① The impulse is equal to the change in momentum. To calculate the impulse from the floor on the ball, we calculate the change in the ball's momentum while it is in contact with the floor.

$\vec{I} = m(\vec{v_f} - \vec{v_i})$

We pick up to be positive and find the initial and final velocities:

For v_i, we use the information about the ball's fall:

$KE_f = PE_i$, since $KE_i = 0$ and $PE_f = 0$

$\frac{1}{2}mv^2 = mgh \quad v = \sqrt{2gh} = \sqrt{2(9.8\frac{m}{s^2})(1.25m)} = |v_i|$

We know the velocity is directed downward, so we get:

$\vec{v_i} = -\sqrt{2(9.8\frac{m}{s^2})(1.25m)} = -4.95\frac{m}{s}$

We do the same in order to find $\vec{v_f}$, except that for the upward bounce we have: $PE_i = 0$, $KE_f = 0$ and we get $KE_i = PE_f$

$\frac{1}{2}mv^2 = mgh \quad v = \sqrt{2gh} = \sqrt{2(9.8\frac{m}{s^2})(0.960m)} = 4.33\,m/s = |v_f|$

We know v_f is upward, so $\vec{v_f} = 4.33\,m/s$

$\vec{I} = m(\vec{v_f} - \vec{v_i}) = (0.150\,kg)(4.33\frac{m}{s} + 4.95\frac{m}{s}) = \boxed{1.39\ N \cdot s}$

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

then $v_{ball} = \frac{m_{bullet}v_{bullet}}{m_{ball}} = \frac{(3.00\times10^{-3}\text{ kg})(1.50\times10^{3}\text{ m/s})}{0.145\text{ kg}} = \boxed{31.0\text{ m/s}}$.

(b) The kinetic energy of the bullet is

$$KE_{bullet} = \frac{1}{2}m_{bullet}v_{bullet}^2 = \frac{(3.00\times10^{-3}\text{ kg})(1.50\times10^{3}\text{ m/s})^2}{2} = 3.38\times10^{3}\text{ J}$$

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

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

7 First we want to know the impact velocity of the diver as she hits the water:

$KE_f = PE_i$ $\quad \frac{1}{2}\cancel{m}v^2 = \cancel{m}gh \quad |\vec{v}| = \sqrt{2gh} \quad \vec{v} = -\sqrt{2gh}$ (downward)

Then we look at the impulse on the car during the impact (counting the impact time as the time it takes the diver to slow down.)

$$I = F\cdot t_{impact} = m(v_f - v_i) = -mv_i = m\sqrt{2gh}$$

$$F = \frac{m\sqrt{2gh}}{t_{impact}}$$

If we assume that she weighs 50 kg and that it takes her 1.0s to stop we get $F = \frac{50\text{kg}\sqrt{2(9.8\frac{m}{s^2})10m}}{1.0s} = 700\ N$, or on the order of $10^3 N$

TA

(12) We add up the area under the curve again:

$\frac{1}{2}(2s)(4N) + 1s \cdot 4N + \frac{1}{2}(2s)(4N) = \boxed{12\ N \cdot s}$

b) $12\ N \cdot s = 2.00(v_f - \cancel{v_i}) \Rightarrow v_f = \boxed{6\ \frac{m}{s}}$

c) $12\ N \cdot s = 2.00\ kg(v_f - (-2.00\frac{m}{s}))$

$$v_f = \frac{12\ N \cdot s - 2.00\ kg \cdot 2.00\frac{m}{s}}{2.00\ kg} = \boxed{4\ \frac{m}{s}}$$

6.15 (a) $\Delta t = \frac{\Delta x}{\bar{v}} = \frac{2(\Delta x)}{v_f + v_i} = \frac{2(1.20\text{ m})}{0 + 25.0\text{ m/s}} = \boxed{9.60 \times 10^{-2}\text{ s}}$

(b) $\bar{F} = \frac{\Delta p}{\Delta t} = \frac{m(\Delta v)}{\Delta t} = \frac{(1400\text{ kg})(25.0\text{ m/s})}{9.60 \times 10^{-2}\text{ s}} = \boxed{3.65 \times 10^5\text{ N}}$

(c) $\bar{a} = \frac{\Delta v}{\Delta t} = \frac{25.0\text{ m/s}}{9.60 \times 10^{-2}\text{ s}} = 260\text{ m/s}^2 = (260\text{ m/s}^2)\left(\frac{1\ g}{9.80\text{ m/s}^2}\right) = \boxed{26.6\ g}$

(18) We assume there is no friction at all.

$m_1 = 730N / 9.8\frac{m}{s^2} = 74.5kg$ (man) $\quad m_2 = 1.2kg$ (book)

$\cancel{m_1 v_{1i}} + \cancel{m_2 v_{2i}} = m_1 v_{1f} + m_2 v_{2f}$

$m_1 v_{1f} = -m_2 v_{2f}$

If we take north to be negative, we get:

$74.5kg \cdot V_{1f} = -1.2kg(-5.0\frac{m}{s}) \qquad V_{1f} = 0.081\frac{m}{s}$

$x = Vt \rightarrow t = \frac{x}{v} = \frac{5.0m}{0.081\frac{m}{s}} = \boxed{62s}$

6.20 (a) The mass of the rifle is $m = \frac{w}{g} = \frac{30\ \text{N}}{9.80\ \text{m/s}^2} = 3.1\ \text{kg}$. We choose the direction of the bullet's motion to be negative. Then, conservation of momentum gives

$$\left(m_{rifle}v_{rifle} + m_{bullet}v_{bullet}\right)_f = \left(m_{rifle}v_{rifle} + m_{bullet}v_{bullet}\right)_i$$

or $(3.1\ \text{kg})v_{rifle} + (5.0\times10^{-3}\ \text{kg})(-300\ \text{m/s}) = 0 + 0$ and $v_{rifle} = \boxed{0.49\ \text{m/s}}$.

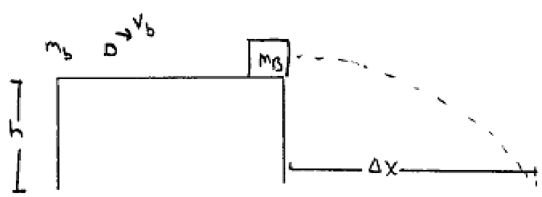
(b) The mass of the man plus rifle is $m = \frac{730\ \text{N}}{9.80\ \text{m/s}^2} = 74.5\ \text{kg}$. We use the same approach as in (a), to find $v = \left(\frac{5.0\times10^{-3}\ \text{kg}}{74.5\ \text{kg}}\right)(300\ \text{m/s}) = \boxed{2.0\times10^{-2}\ \text{m/s}}$.

6.26 For each skater, the impulse-momentum theorem gives

$$\overline{F} = \frac{\Delta p}{\Delta t} = \frac{m(\Delta v)}{\Delta t} = \frac{(75.0\ \text{kg})(5.00\ \text{m/s})}{0.100\ \text{s}} = \boxed{3.75\times10^3\ \text{N}}$$

Since $\overline{F} < 4500\ \text{N}$, there are $\boxed{\text{no broken bones}}$.

$\boxed{30}$



m_b = mass of bullet = 8 g
m_B = mass of block = 250 g
$M = m_b + m_B$ = 258 g

$h = 1\ m$
$\Delta x = 2\ m$

From conservation of momentum we have $\vec{p}_i = m_b \vec{v}_0 = \vec{p}_f = M\vec{v}_f$

then $\vec{v}_0 = \frac{M}{m_b}\vec{v}_f$ $\quad$ $\vec{v}_f$ we can find by looking at the kinematics of the block / bullet mass as it falls

In the y-direction, the block / bullet mass has a constant acceleration $a = -g = -9.8\ m/s$

then

$\Delta y = v_{oy}t - \frac{1}{2}gt^2$, but $v_{oy} = 0$, $\Delta y = -h$

then $t = \sqrt{\frac{2h}{g}}$ is the time it takes for the block to fall to the floor

Since there is no acceleration in the x-direction, $\Delta x = v_{ox}t \Rightarrow v_{ox} = \frac{\Delta x}{t} = \Delta x \cdot \sqrt{\frac{g}{2h}}$

then $v_{ox} = \Delta x\sqrt{\frac{g}{2h}}$ $\quad$ We know that v_{ox} is just $\vec{v}_f$

Then

$$v_0 = \frac{M}{m_b}v_f = \frac{M}{m_b}\Delta x\sqrt{\frac{g}{2h}} = \left(\frac{258\ g}{8\ g}\right)(2\ m)\sqrt{\frac{9.8\ m/s^2}{2\ m}} = 142.77\ m/s$$

Then the initial velocity of the bullet is $v_0 = 143\ m/s$

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

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

Conservation of momentum in the y direction gives

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

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

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

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

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

$= \boxed{7.9\times10^2\text{ J}}$ converted into internal energy