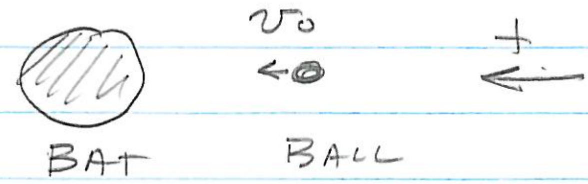
Chapter 7

7-6



$v_0 = +40.2\ m/s$ $\quad$ $m = 0.149\ kg$

$v_f = -45.6\ m/s$

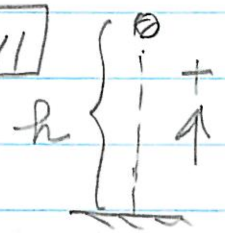
$$\bar{F}\Delta t = \Delta p = p_f - p_o$$

$$\bar{F}(1.1\times 10^{-3}\ s) = 0.149\,(-45.6 - 40.2)$$

$$\therefore \quad \bar{F} = -11{,}622\ N$$

7-11

force exerted by ground on STUDENT



$$\bar{F}\Delta t = \Delta p = p_f - p_o$$

$$\bar{F}\Delta t = 0 - mv_0$$

NOTE v_0 here refers to the velocity just before impact.

$$\Rightarrow \quad v_0 = \frac{-F\Delta t}{m}$$

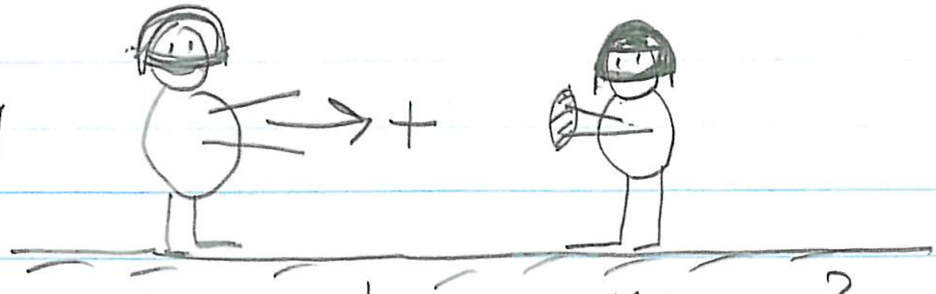
Mag. $$v_0 = \frac{18{,}000\ N \times 0.04\ s}{63\ kg} = 11.4\ m/s$$

Using Consv. of energy

$$mgh = \tfrac{1}{2}mv_0^2$$

$$h = \frac{v_0^2}{2g} = 6.7\ m$$

6-17



$m_T = 115\,kg$ $\quad m_R = ?$

$v_T = +4.5\,m/s$ $\quad v_f = 2.6$

$p_{before} = p_{after}$

$m_T v_T = (m_T + m_R)\, v_f$

$115 \cdot 4.5 = 115 \times 2.6 + m_R \times 2.6$

$517.5 = 299 + 2.6\, m_R$

$218.5 = 2.6\, m_R$

$m_R = 84\,kg$

This is an example of a totally inelastic collision.

7-18

$$p_0 = p_f$$

$$(m_1+m_2)v_0 = m_1 v_{1f} + m_2 v_{2f}$$

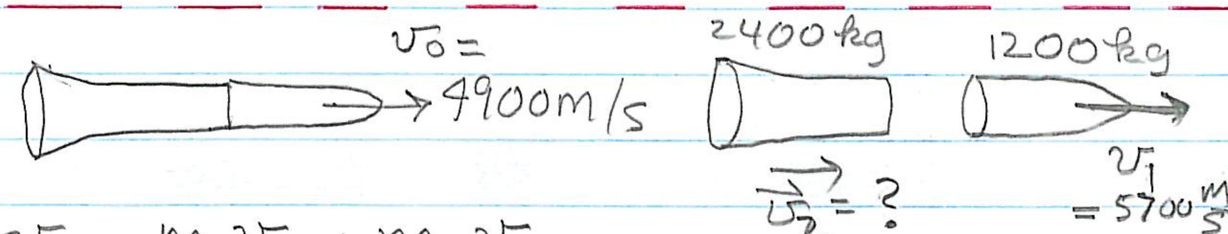
$$v_{1f} = 0$$

$$v_{2f} = \frac{m_1+m_2}{m_2} v_0$$

$$= \left(\frac{1.2\,kg + 2.4\,kg}{2.4\,kg}\right) \times 5\,m/s$$

$$= \frac{3.6}{2.4} \times 5 = \underline{7.5\,m/s}$$

7-21



$$M v_0 = m_1 v_1 + m_2 v_2$$

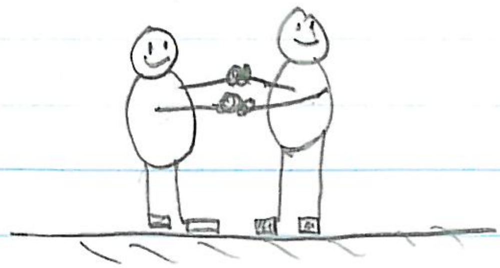
$$3600 \times 4.900 = 1200 \times 5.700 + 2400\, v_2$$

$$17640\, kg\, \frac{km}{s} = 6840\, kg\, \frac{km}{s} + 2400\, v_2$$

$$10800 = 2400\, v_2$$

$$\underline{v_2 = +4.5\, km/s} \implies$$

7-25



$p_0 = p_f$ *

Before they push off: $p_0 = 0$

immediately after push off $p_f = m_1 v_1 + m_2 v_2$

after separation: $v_f^2 = 0 = v_0^2 - 2ax$

1: $0 = v_1^2 - 2ax_1$

2: $0 = v_2^2 - 2ax_2$

$x_1 = 2x_2$

$v_1^2 = 2a(2x_2)$
$v_2^2 = 2a\,x_2$ $\Big\} \left(\frac{v_1}{v_2}\right)^2 = 2$

but $m_1 v_1 = -m_2 v_2$

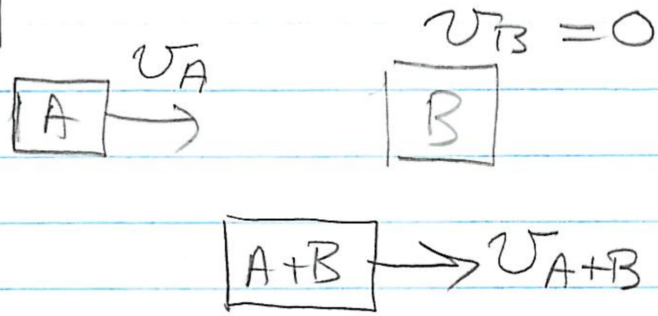
magnitude $\frac{m_1}{m_2} = \frac{v_2}{v_1} = \frac{1}{\sqrt{2}} =$

$= \underline{\underline{0.707}}$

* during the "collision" (push off) friction can be ignored

7-30

$m_A = 3.0\,kg$
$m_B = 8.0\,kg$



CASE 1 : A → B (small on big)

$$m_A v_A = (m_A + m_B) v_{A+B}$$ ← TOTALLY INELASTIC COLLISION

$$v_{A+B} = \frac{m_A}{m_A + m_B} v_A$$

$$= \frac{3}{11} \times 25 = \underline{6.82\,m/s}$$

CASE 2: B → A (big on small)

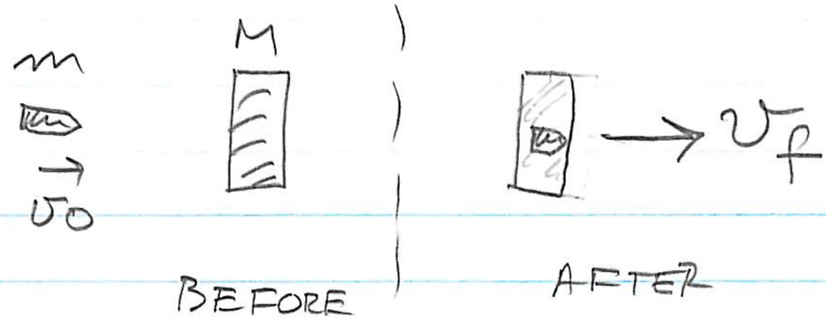
$$m_B v_B = (m_A + m_B) v_{A+B}$$

$$v_{A+B} = \frac{m_B}{m_A + m_B} \cdot v_B$$

$$= \frac{8}{11} \cdot 25$$

$$= \underline{18.2\,m/s}$$

7-31



$m = 0.2\ kg$
$M = 2.5\ kg$

Momentum Conservation

$$m v_0 = (m+M) v_f$$

$$\Rightarrow v_f = \frac{m v_0}{m+M}$$

$$KE_f = \frac{1}{2}(m+M) v_f^2 = \frac{1}{2}(m+M)\frac{m^2}{(m+M)^2} v_0^2$$

$$KE_0 = \frac{1}{2} m v_0^2$$

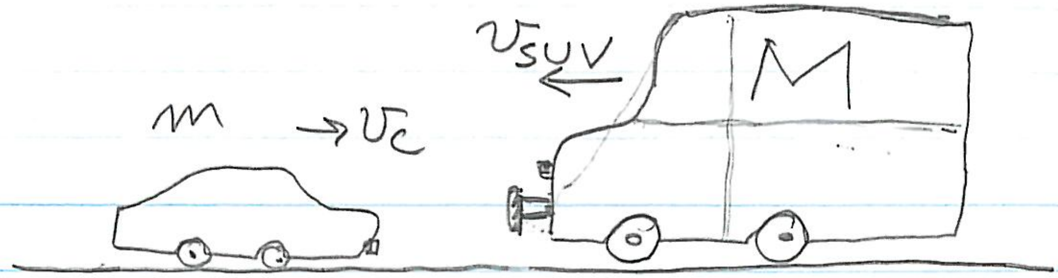
$$\frac{KE_f}{KE_0} = \frac{\frac{1}{2}\frac{m^2}{(m+M)} \cdot v_0^2}{\frac{1}{2} m v_0^2}$$

$$= \frac{m}{m+M} = \frac{0.2}{2.7}$$

$$= \underline{\underline{0.074 \text{ or } 7.4\%}}$$

Most of the oreginal KE IS USED in embedding the projectile and creating heat.

7-32



$$m v_c - M v_{SUV} = 0$$

$$v_{SUV} = \frac{m}{M} v_c = \frac{1100}{2500} \times 32\,m/s$$

$$\underline{v_{SUV} = 14\,m/s}$$

7-33

$m_1 = 5\,kg$, $m_2 = 7.5\,kg$, $v_{10} = 2\,m/s$

(a) elastic (KE is conserved)

Momentum: $m_1 v_{10} + m_2 v_{20} = m_1 v_{1f} + m_2 v_{2f}$

KEnergy: $\frac{1}{2} m_1 v_{10}^2 + \frac{1}{2} m_2 v_{20}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$

$v_{10} = 2\,m/s$, $v_{20} = 0$, so there are 2 unnowns v_{1f} and v_{2f}

The solutions were worked out in Example 7 onpages 205 & 206

$$v_{f1} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_{01} \quad (7.8a) \qquad ; \qquad v_{f2} = \left(\frac{2 m_1}{m_1 + m_2}\right) v_{01} \quad (7.8b)$$

7-33, continued

$$v_{f1} = \left(\frac{5-7.5}{5+7.5}\right) \times 2\,m/s = -0.4\,m/s$$

$$v_{f2} = \left(\frac{2.5}{5+7.5}\right) \times 2 = +1.6\,m/s$$

(b) TOTALLY inelastic (STICK TOGETHER)

$$m_1 v_{1o} = (m_1 + m_2) v_f$$

$$v_{1f} = \left(\frac{m_1}{m_1+m_2}\right) v_{1o}$$

$$= \frac{5}{12.5} \cdot 2$$

$$= +0.8\,m/s$$

7-39

(a) $m_1 v_{10} = (m_1 + m_2) v_f$

$$v_f = \frac{m_1}{m_1 + m_2} v_0 = \frac{2100}{2100 + 1900} \times 17 m/s$$

$$= \underline{8.93 \ m/s}$$

(b) $\vec{J} = \vec{\Delta p} = \vec{p_f} - \vec{p_0} = 0 - \vec{p_0}$

$$J = -(m_1 + m_2) v_f$$

$$= -4000 \times 8.93$$

$$= \underline{-35,700 \ kg\ m/s}$$

(c) $E_f - E_0 = W_f$

$$0 - \frac{1}{2}(m_1 + m_2) v_f^2 = -\mu_k (m_1 + m_2) g S$$

$$S = \frac{v_f^2}{2 \mu_k g} = \frac{(8.93)^2}{2 \times 0.68 \times 9.8}$$

$$\simeq \underline{6m}$$