if 1 object moving, 1 object stationary

$$v_1' = \frac{v_1(m_1 - m_2)}{(m_1 + m_2)} \qquad v_2' = \frac{2m_1v_1}{(m_1 + m_2)}$$

Air gliders →

1

(4)

(a) $m_1 = 0.2\,kg$
$v_1 = 1\,m/s$
$m_2 = 0.05\,kg$
$v_2 = 0\,m/s$

a) $v_1' = \frac{1(0.2-0.05)}{0.25}$ = 0.6 m/s [fwd]

$v_2' = \frac{2(0.2)(1)}{0.25}$ = 1.6 m/s [fwd]

check → con. of mom. $p \stackrel{?}{=} p'$

$m_1v_1 + m_2v_2 \stackrel{?}{=} m_1v_1' + m_2v_2'$

$(0.2)(1) + 0 = (0.2)(0.6) + (0.05)(1.6)$

$0.2 = 0.12 + 0.08$

$0.2 = 0.2$

b) $\vec{p} = \vec{p}$

before collision / during collision

$m_1v_1 + m_2v_2 = (m_1 + m_2)V$ ← during collision masses are acting as on

$(0.2)(1) + (0.05)(0) = (0.25)V$

$v = 0.8\,m/s$ [fwd]

(3)

c) $TME_{start} = TME_{collision}$

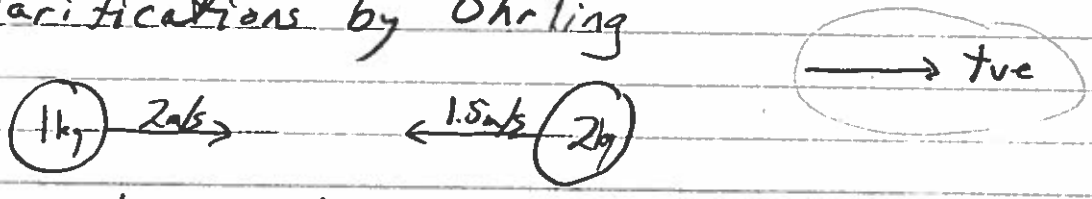
$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_{(1+2)}v_{(1+2)}^2 + \text{stored energy}$

$\frac{1}{2}(0.2)(1)^2 + \frac{1}{2}(0.05)(0)^2 = \frac{1}{2}(0.25)(0.8)^2 + \text{stored}$

$0.1 + 0 = 0.08 + \text{stored}$

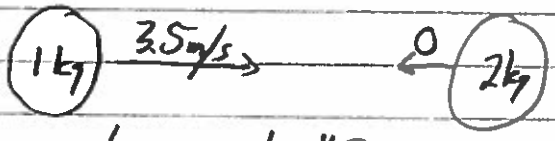
stored = 0.02 J

#2 Again- this time a different Elliott sol'n with clarifications by Ohrling



motion wrt ground

but our formulas only work if one object is stationary
So... change frame of ref by "adding" +1.5 m/s to both



new motion wrt #2

$$v_1' = \frac{v_1(m_1 - m_2)}{m_1 + m_2} \qquad v_2' = \frac{2m_1 v_1}{m_1 + m_2}$$

$$= \frac{3.5(-1)}{3} \qquad = \frac{2(1)(3.5)}{3}$$

$$= -1.1667 \text{ m/s} \qquad = 2.33 \text{ m/s}$$

But... to get back to "wrt ground" we need to "subtract" the 1.5 m/s we added to both sides

$$v_1' = -1.1667 - 1.5 \qquad v_2' = 2.33 \text{ m/s} - 1.5$$

$$= -2.667 \text{ m/s} \qquad = 0.833 \text{ m/s}$$

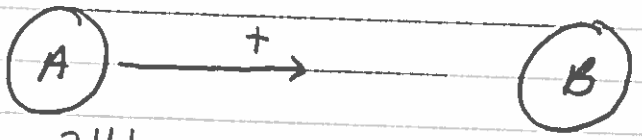
8

Momentum and Energy Problems

$KE_A = \frac{1}{2}mv^2 = 120$

b) $KE_B' = \frac{1}{2}mv^2$
$= (0.5)(36)(8)^2$
$= 115.2\ J$
$\frac{115.2}{120} = 96\%$

3



$m_1 = 2.4\ kg$
$v_1 = 10\ m/s$

$m_2 = 3.6\ kg$
$v_2 = 0$

3

6

a) $v_1' = \frac{v_1(m_1 - m_2)}{m_1 + m_2}$

$= \frac{10(2.4 - 3.6)}{2.4 + 3.6}$

$= -2\ m/s$

$v_2' = \frac{2m_1v_1}{(m_1 + m_2)}$

$= \frac{2(2.4)(10)}{2.4 + 3.6}$

$= 8\ m/s$

4

2

$m_1 = 2\ kg$
$v_1 = 3\ m/s$
$v_1' = 1\ m/s$

$m_2 = 1\ kg$
$v_2 = -2\ m/s$
$v_2' = ?$

a) Cons. of mom.

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

3

$v_2' = \frac{m_1v_1 + m_2v_2 - m_1v_1'}{m_2}$

$v_2' = 2\ m/s \quad (east)$

b) $KE \stackrel{?}{=} KE'$

$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 \stackrel{?}{=} \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$

$(2)(3)^2 + (1)(-2)^2 \stackrel{?}{=} (2)(1)^2 + (1)(-2)^2$

$18 + 4 \stackrel{?}{=} 2 + 4$

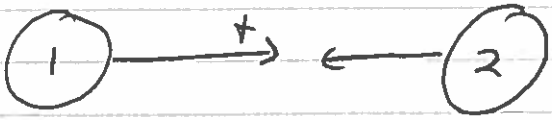
$22 \neq 6$

2

Not elastic!

Momentum and Energy Problems

5



$m_1 = 0.3\ kg$ $\quad$ $m_2 = 0.2\ kg$

$v_1 = 0.5\ m/s$ $\quad$ $v_2 = -1\ m/s$

wrt ground

wrt #2 → "add 1m/s to both"

$m_1 = 0.3\ kg$ $\quad$ $m_2 = 0.2\ kg$

$v_1 = 1.5\ m/s$ $\quad$ $v_2 = 0\ m/s$

a) $v_1' = \dfrac{v_1(m_1 - m_2)}{m_1 + m_2}$ $\qquad$ $v_2' = \dfrac{2m_1v_1}{m_1 + m_2}$

4

$= \dfrac{1.5(0.3-0.2)}{0.3+0.2}$ $\qquad$ $= \dfrac{2(0.3)(1.5)}{0.3+0.2}$

$= 0.3\ m/s$ $\qquad$ $= 1.8\ m/s$

Back to wrt ground by "subtracting 1m/s from both"

$= -0.7\ m/s$ $\qquad$ $= 0.8\ m/s$

3

b) Cons of mom. (stick together)

$m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$

$(0.3)(0.5) + (0.2)(-1) = (0.3 + 0.2)\,v_f$

$0.15 - 0.2 = 0.5\,v_f$

$v_f = -0.1\ m/s$

$KE_{lost} = KE_I - KE_f$

$= \left(\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2\right) - \frac{1}{2}(m_1+m_2)v_f^2$

$= 0.1375 - 0.0025$

$loss = 0.135\ J$

Momentum and Energy Problems

$m_1 = 6\,kg$ $\quad v_1 = 6\,m/s$ $\quad m_2 = 2\,kg$ $\quad v_2 = 2\,m/s$

wrt ground

wrt #2 (subtract 2 m/s from both)

$m_1 = 6\,kg$ $\quad v_1 = 4\,m/s$ $\quad m_2 = 2\,kg$ $\quad v_2 = 0\,m/s$

a) $v_1' = \dfrac{v_1(m_1 - m_2)}{m_1 + m_2}$ $\qquad v_2' = \dfrac{2m_1 v_1}{m_1 + m_2}$

$= \dfrac{4(6-2)}{6+2}$ $\qquad = \dfrac{2(6)(4)}{6+2}$

$= 2\,m/s$ $\qquad = 6\,m/s$

Back to wrt ground by adding 2 m/s

$= 4\,m/s$ $\qquad = 8\,m/s$

---

b) find $\vec{v}$ during collision, Cons. of mom.

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_{coll}$

$(6)(6) + (2)(2) = (8) v_{coll}$

$v_{coll} = 5\,m/s$

$TME_{stored} = TME_{coll}$

$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2}(m_1 + m_2) v_{coll}^2 + \text{stored}$

$(0.5)(6)(6)^2 + (0.5)(2)(2)^2 = 0.5(6+2)(5)^2 + \text{stored}$

$\text{stored} = 12.\,J$