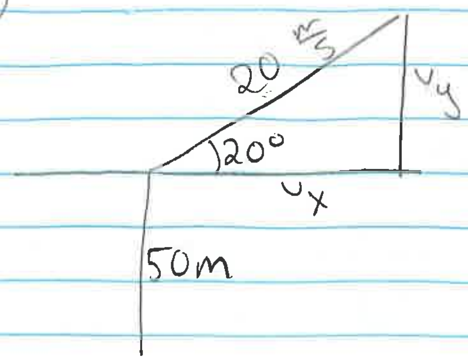
125

Problem Set 6

1)



a) $KE_0 + PE_0 = KE_f$

$\frac{1}{2}(\cancel{m})(20\ \frac{m}{s})^2 + (\cancel{m})(10\ \frac{m}{s^2})(50\ m) = \frac{1}{2}(\cancel{m})(v_f^2)$

$\boxed{v_f = 37.4\ \frac{m}{s}}$

b) The horizontal component of the ball's velocity is always constant, as gravity doesn't affect the x component of velocity.

$\sin(20) = \frac{v_y}{20\ \frac{m}{s}}$

$v_{y_0} = 6.84\ \frac{m}{s}$

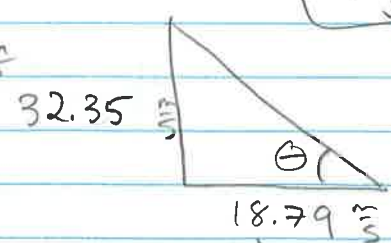
$v_{f_y}^2 = v_{0y}^2 + 2ay$

$v_{f_y}^2 = (6.84)^2 + 2(-10\ \frac{m}{s^2})(50m)$

$\boxed{v_{f_y} = 32.35\ \frac{m}{s}}$

$\cos(20) = \frac{v_x}{20\ \frac{m}{s}}$

$v_{x_0} = 18.79\ \frac{m}{s} = v_{xf}$



$\tan\theta = \frac{32.35\ (\frac{m}{s})}{18.79\ (\frac{m}{s})}$

$\boxed{\theta = 59.85°\ \text{above horizontal}}$

c) $0 = 50m + (6.84\ \frac{m}{s})(t) + \frac{1}{2}(-10\ \frac{m}{s^2})(t^2)$

$-5t^2 + 6.84t + 50 = 0$

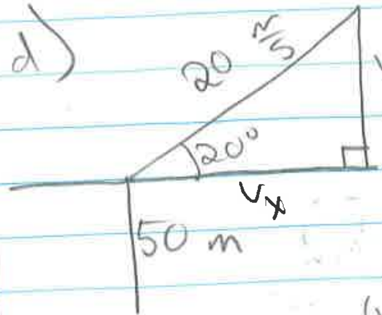
$5t^2 - 6.84t - 50 = 0$

$\boxed{t = 3.92\ s}$

$x = 0m + (18.79\ \frac{m}{s})(3.92\ s) + \frac{1}{2}(0)(3.92\ s^2)$

$\boxed{x = 73.66\ m}$

d)



$v_x = \cos(20)(20\ \frac{m}{s})$

$v_x = 18.79\ \frac{m}{s}$

$v_y = \sin(20)(20\ \frac{m}{s})$

$v_{y_0} = 6.84\ \frac{m}{s}$

$v_{fy}^2 = v_{oy}^2 + 2ay$

$(v_{fy})^2 = (6.84\ \frac{m}{s})^2 + 2(10\ \frac{m}{s})(50\ m)$

$v_{fy} = 32.35\ \frac{m}{s}$

$\rightarrow 0 = 50\ m + (6.84\ \frac{m}{s})t + \frac{1}{2}(-10\ \frac{m}{s^2})(t^2)$

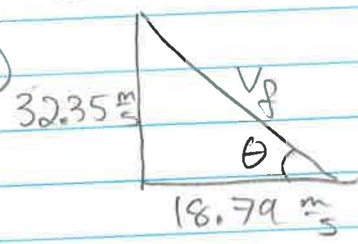
$-5t^2 + 6.84t + 50 = 0$

$\boxed{t = 3.92s}$

e) $x = 0m + (18.79\ \frac{m}{s})(3.92s) + \cancel{\frac{1}{2}(0\ \frac{m}{s^2})(3.92\ s)^2}$

$\boxed{x = 73.66\ m}$

f)



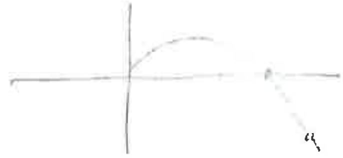
$(18.79\ \frac{m}{s})^2 + (32.35\ \frac{m}{s})^2 = v_f^2$

$v_f = 37.4\ \frac{m}{s}$

$\tan(\theta) = \frac{32.35\ \frac{m}{s}}{18.79\ \frac{m}{s}}$

$\theta = 59.85°$

$v_f = 37.4\ \frac{m}{s}$ at 59.85° above the horizontal



Problem Set #6

2) a) - for horizontal velocity, the initial V_x is calculated using $\cos(\theta)$ and v_0 of the ball. V_x stays constant, so $v_{fx} = v_{f0}$

- for vertical velocity, the initial v_y is calculated using $\sin(\theta)$ and v_0 of the ball. To calc v_{fy}, it uses the equation $(v_f^2 = v_0^2 + 2ay)$

Position - displacement in both the horizontal and vertical components: $v_y = (y)(t)$, $v_x = (x)(t)$

b) On the level ground if V_0 is doubled, the displacement will increase by ≈ 120 m, or by a factor of ≈ 5. Changing the initial velocity causes both the vertical and horizontal components of v to increase, causing the ball to stay in the air longer and causing the ball to travel further. This causes the ball's distance to increase dramatically, because both v_{y0} and v_{x0} increase.

c) Yes, it seems that the 45° angle will maximize the distance the ball is hit. When the ball is hit from the top of a cliff, an angle of $\approx 30°$ maximizes the horizontal distance. This angle changes because the cliff gives the ball more time in the air. Horizontal velocity is not affected by gravity, so having more initial horizontal velocity (caused by a smaller θ) for more time will cause the ball to travel further.

d) a) $\boxed{v_{f\,ball} = 36.7 \frac{m}{s}}$

b) vertical velocity$_0$ = 6.84 $\frac{m}{s}$ ↑
vertical velocity$_f$ = 31.5 $\frac{m}{s}$ ↓
θ_f = 59.2° above the horizon

c) $t_{\text{in the air}} = 3.9$ s

horizontal distance = 74 m

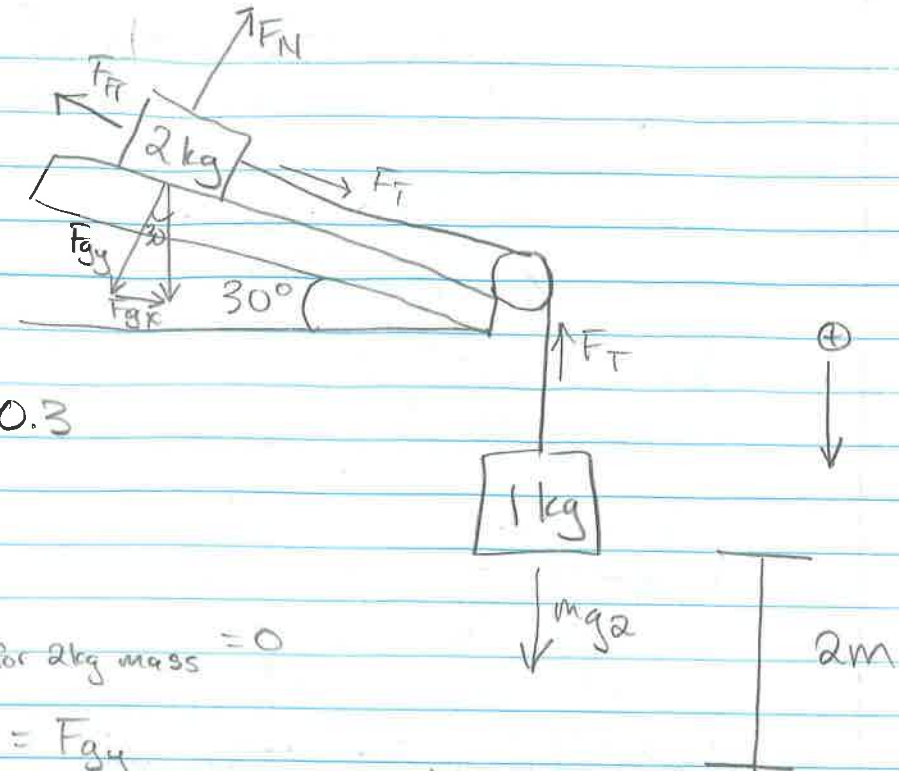
velocity$_f$ = 37 $\frac{m}{s}$ at $\theta = 59.2°$

I liked solving this problem by splitting it up into horizontal and vertical components. The excel sheet is nice because it calculates the values instantly, however, it takes awhile to set up an excel sheet.

Brady H
- TA

Problem Set #6

3)

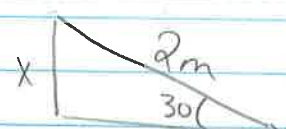


$\mu = 0.3$

a) $\sum F_{y\,\text{for 2kg mass}} = 0$

$F_N = F_{gy}$
$F_N = \cos(30)(2\text{ kg})(10\ \frac{m}{s^2})$
$F_N = 17.32\ N$
$F_{Fr} = \mu F_N$
$F_{Fr} = (0.3)(17.32\ N)$
$F_{Fr} = 5.196\ N$
$W_{Fr} = F_{Fr} \cdot d$
$W_{Fr} = (5.196\ N)(2\ m)$
$\boxed{W_{Fr} = \text{heat}_E \text{ liberated} = 10.4\ J}$

b)



$\sin(30) = \frac{x}{2m}$
$x = 1\ m$

$\Delta PE = -PE_0 + PE_f$ ← PE final
$\Delta PE = \left[-(2\text{kg})(10\ \frac{m}{s^2})(1\ m) + -(1\text{ kg})(10\ \frac{m}{s^2})(2m)\right] + 0\ J$
$\boxed{\Delta PE = -40\ J}$

c) conservation of energy will be used
$\Delta PE_0 = \Delta KE_f + \Delta TE$
$40\ J = \frac{1}{2}(2\text{ kg} + 1\text{ kg})(v)^2 + 10.4$
$\boxed{V_{f\,\text{system}} = 4.44\ \frac{m}{s}}$

d) $v_{avg} = \frac{v_0 + v_f}{2}$ $\quad v_{avg} = \frac{0 + 4.44\ \frac{m}{s}}{2}$

$\boxed{v_{avg} = 2.22\ \frac{m}{s}}$

$\Delta x = (v_{avg})(t)$ $\quad v_f^2 = v_0^2 + 2ax$

$2m = (2.22\ \frac{m}{s})(t)$

$\boxed{t = .90\ s}$

$\vec{v_f} = v_0 + at$

$4.44\ \frac{m}{s} = 0 + (a)(.90\ s)$

$\boxed{a = 4.93\ \frac{m}{s^2}}$

e) $\sum F_{1kg\ mass} = m a_{1kg\ mass}$

$mg - F_T = ma$

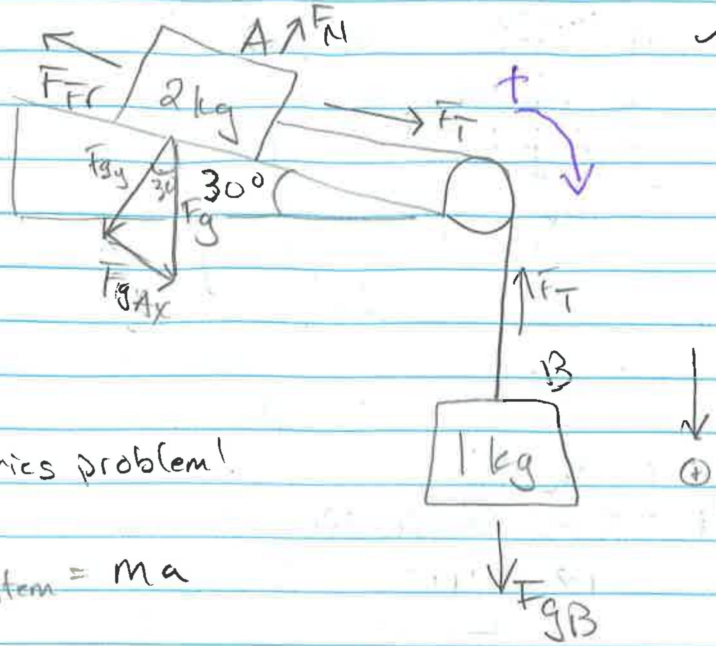
$(1\ kg)(10\ \frac{m}{s^2}) - F_T = (1\ kg)(4.93\ \frac{m}{s^2})$

$\boxed{F_T = 5.07\ N}$

Brady H

Problem Set #6

4) $\mu = 0.3$



* dynamics problem!

$$\sum F_{system} = ma$$

$$F_{g_B} + F_{g_{Ax}} - F_{Fr} = ma$$

$$(1\,kg)(10\,\tfrac{m}{s^2}) + (\sin 30)(2\,kg)(10\,\tfrac{m}{s^2}) - (0.3)F_N = (1+2\,kg)(a)$$

$$\sum F_{y_A} = 0$$

$$F_{g_y} = F_N$$

$$\cos(30)(2\,kg)(10\,\tfrac{m}{s^2}) = F_N$$

* $F_N = 17.32$

$$\sum F = ma$$

$$10\,N + 10\,N - (0.3)(17.32\,N) = (3\,kg)(a)$$

$$\boxed{a = 4.93\,\tfrac{m}{s^2}}$$

$$\sum F_B = F_{g_B} - F_T = ma$$

$$(1\,kg)(10\,\tfrac{m}{s^2}) - F_T = (1\,kg)(4.93\,\tfrac{m}{s^2})$$

$$\boxed{F_T = 5.07\,N}$$

$$y_f = y_0 + v_0 t + \tfrac{1}{2}at^2$$

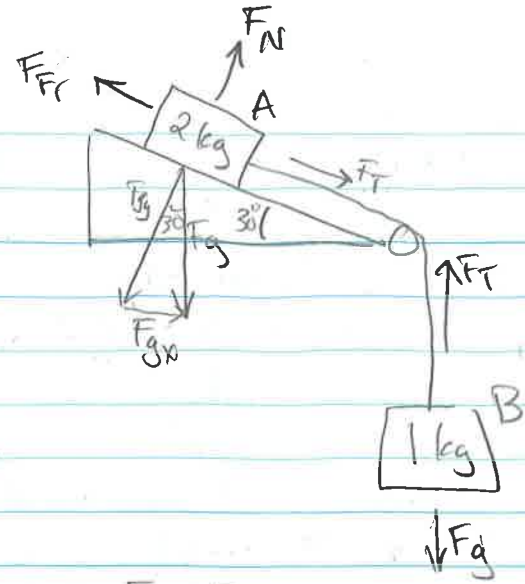
$$0\,m = 2\,m + \tfrac{1}{2}(-4.93\,\tfrac{m}{s^2})(t^2)$$

$$t = .9\,s$$

$$v = a(t)$$

$$v_f = (4.93\,\tfrac{m}{s^2})(.9\,s) \qquad \boxed{v_f = 4.4\,\tfrac{m}{s}}$$

5)



$\mu = 0.3$

$\sum F_{y_A} = 0 = F_{gy} - F_N$

$F_N = \cos(30)(2kg)(10\frac{m}{s^2})$

☆ $F_N = 17.3$ N

$\sum F_{x_A} = F_T + F_{gx} - F_{Fr} = ma$

$F_T + (\sin 30)(2kg)(10\frac{m}{s^2}) - (0.3)(17.3N) = (a)(2kg)$

$F_T + 4.81 = (2kg)(a)$

$a = \frac{F_T + 4.81}{2kg}$

$\sum F_B = F_g - F_T = ma$

$(1kg)(10\frac{m}{s^2}) - F_T = (1kg)(a)$

$10\frac{kg\,m}{s^2} - F_T = \frac{F_T + 4.81}{2kg}$

$20 - 2F_T = F_T + 4.81$

$20 = 3F_T + 4.81$

$3F_T = 15.19$ N

$\boxed{F_T = 5.06\text{ N}}$

$a = \frac{(5.06\text{ N}) + 4.81}{2kg}$

$\boxed{a = 4.94\ \frac{m}{s^2}}$

$2m = 0m + \frac{1}{2}(4.94\frac{m}{s^2})t^2$

$t = .9$ s

☆ I like #4 the best

$v_f = a(t)$

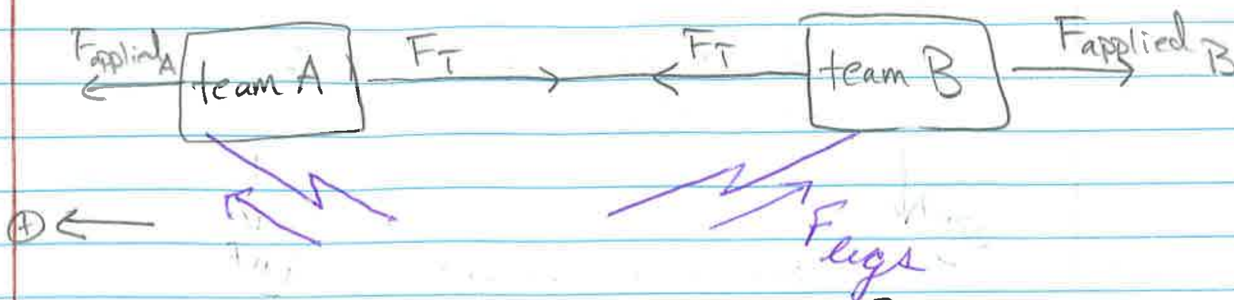
$v_f = (4.94\frac{m}{s^2})(.9s)$ $\boxed{v_f = 4.44\ \frac{m}{s}}$

Hill

Problem Set #6

6) dynamics problem

$\sum F = ma$



In this system, the forces we will focus on are F_T and $F_{applied}$ by both team A and team B. No matter how hard a team pulls, tension will act equally of each team, so F_T is basically irrelevant. The only forces left are force applied. The team that applies the most force on the system will cause the system to accelerate in that direction, causing a team to win. If Team A applies more force, the system will accelerate to the left and Team A will win.

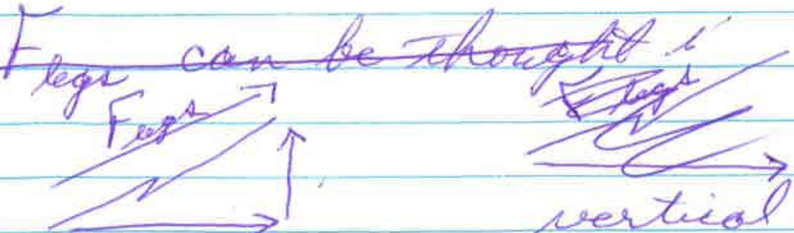
$$\sum F = ma$$

$$F_{applied_A} - F_{applied_B} + F_T - F_T = ma$$

$$\boxed{F_{applied_A} - F_{applied_B} = ma}$$

~~The~~ the force applied of the feet of one team is greater than the force applied by the other team's feet, then that team will win.

~~F_{legs} can be thought~~



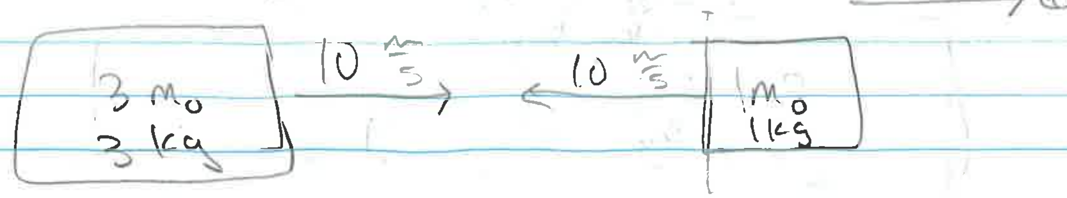
$\sum F_y = ma_y = 0$

vertical component of ~~normal~~ $F_{legs} = mg$

$F_H \cong F_{applied_B}$

Problem Set #6

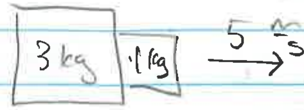
7) $v_0 = 10\ \frac{m}{s}$



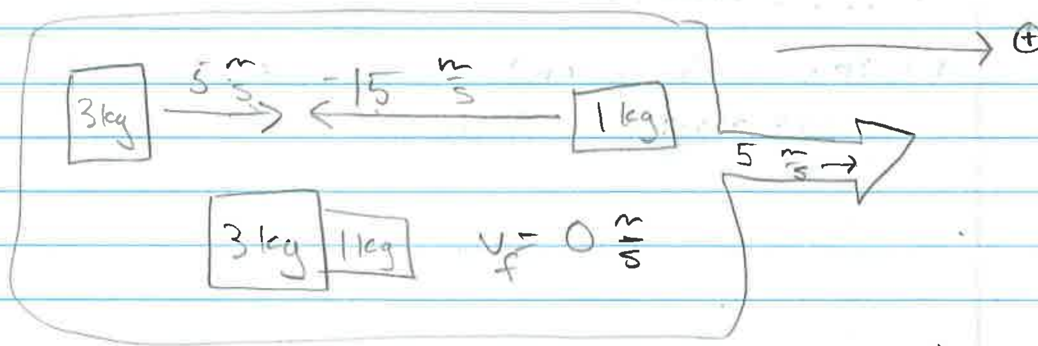
a) $p_0 = p_f$

$(3\text{ kg})(10\ \frac{m}{s}) - (1\text{ kg})(10\ \frac{m}{s}) = (4\text{ kg})(v_f)$

$\boxed{v_f = 5\ \frac{m}{s} \rightarrow}$



b)



c) $P_{left} = (3\text{ kg})(5\ \frac{m}{s})$ $\qquad$ $P_{right} = (1\text{ kg})(-15\ \frac{m}{s})$

$\boxed{P_{left} = 15\text{ kg}\ \frac{m}{s}}$ $\qquad$ $\boxed{P_{right} = -15\text{ kg}\ \frac{m}{s}}$

$P_{system} = (15\text{ kg}\ \frac{m}{s} - 15\text{ kg}\ \frac{m}{s})$

$\boxed{P_{system} = 0\text{ kg}\ \frac{m}{s}}$

d) The velocities in the C.O.M. reference are the same, but in opposite directions.

$\boxed{V_{3kg} = -5\ \frac{m}{s}}$ $\qquad$ $\boxed{V_{1kg} = 15\ \frac{m}{s}}$

e) convert back to lab frame (add C.O.M. velocity to each)

$V_{3kg} = -5\ \frac{m}{s} + 5\ \frac{m}{s} = 0\ \frac{m}{s}$ $\qquad$ $\boxed{V_{3kg} = 0\ \frac{m}{s}}$

$V_{1kg} = 15\ \frac{m}{s} + 5\ \frac{m}{s} = 20\ \frac{m}{s}$ $\qquad$ $\boxed{V_{1kg} = 20\ \frac{m}{s}}$

f) $P_0 = (3\,kg)(10\,\frac{m}{s}) + (1\,kg)(-10\,\frac{m}{s})$

$\boxed{P_0 = 20\ kg \cdot \frac{m}{s}}$

$P_f = (3\,kg)(0\,\frac{m}{s}) + (1\,kg)(20\,\frac{m}{s})$

$\boxed{P_f = 20\ kg\,\frac{m}{s}}$

g) $KE_0 = \frac{1}{2}(3\,kg)(10\,\frac{m}{s})^2 + \frac{1}{2}(1\,kg)(10\,\frac{m}{s})^2$

$\boxed{KE_0 = 200\ J}$

$KE_f = \frac{1}{2}(3\,kg)(0\,\frac{m}{s})^2 + \frac{1}{2}(1\,kg)(20\,\frac{m}{s})^2$

$\boxed{KE_f = 200\ J}$

h) Yes, both p and energy were conserved in the elastic collision.