15.28 No Forces acting in x-direction

$\therefore \bar{x} = \text{constant}$

$$m_A x_A + m_B x_B = (m_A + m_B)\bar{x}$$

since $\bar{x}$ constant $\frac{d\bar{x}}{dt} = 0$

$$m_A v_A + m_B v_B = 0$$

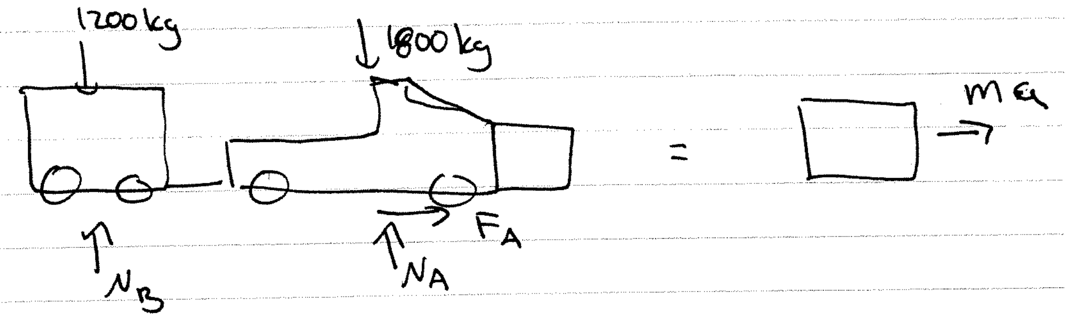
$$v_B = -v_A \left(\frac{m_A}{m_B}\right)$$

$v_A = -4.8$
$m_A = 20/32.2$
$m_B = .08/32.2$

$$v_B = 1200 \text{ ft/s}$$

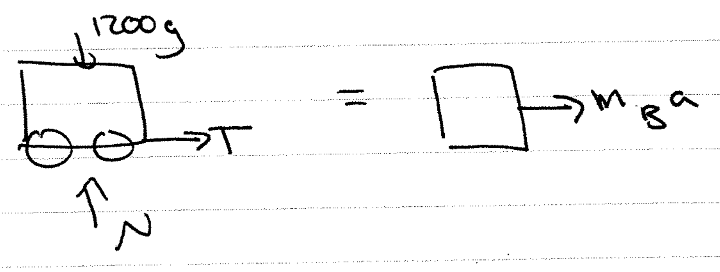
Muzzle velocity $= v_{B/A} = v_B - v_A =$ **$1204.8 \text{ ft/s} = v_{B/A}$**

15.32



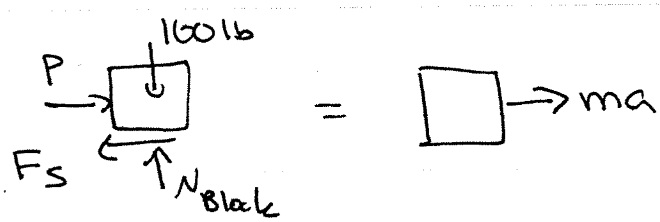
$\sum F_x = F_A = ma \qquad F_A = .9\,N_A = .9(1800)(9.8)$

$$a = \frac{.9(1800)(9.8)}{(3000)} = 5.3\ \text{m/s}^2$$



$T = m_B a = (1200)\cancel{(9.8)}(5.3) = \boxed{6.36\ \text{kN} = T}$

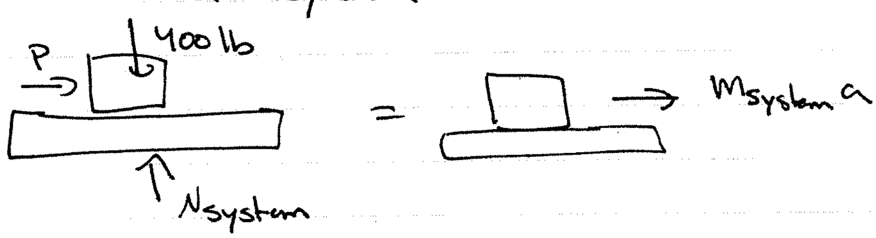
15.34 Maximum acceleration w/o slipping occurs when $F_s = F_{s\,max} = \mu N$



$$P - F_s = ma$$

$$P - .24(100) = \frac{100}{32.2}\,a$$

For whole system



$$P = \left(\frac{400}{32.2}\right)a$$

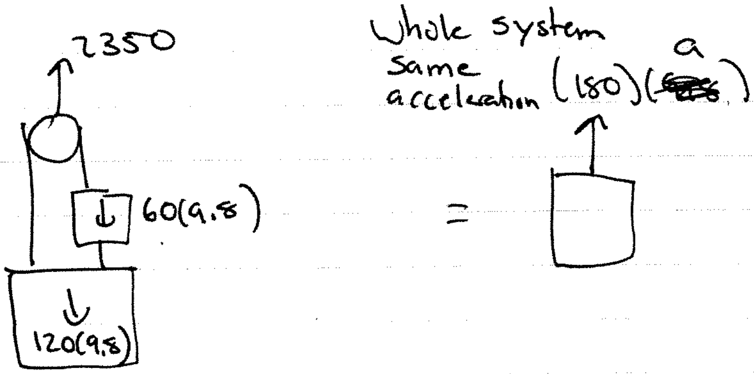
$$\therefore\ a = \frac{32.2P}{400} \quad \text{plug in above}$$

$$P - 24 = \frac{100}{32.2}\left(\frac{32.2}{400}\right)P$$

$$P - 24 = .25P$$

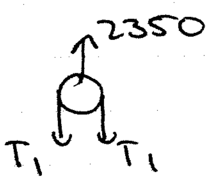
$$\boxed{P = 32\,lb}$$

15.36



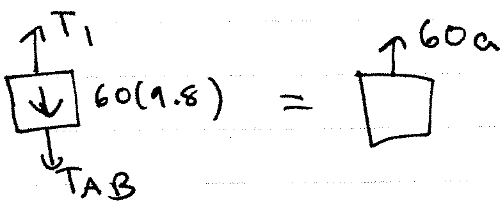
$$2350 - 60(9.8) - 120(9.8) = 180a$$

$$a = 3.246\, m/s^2$$



$$2T_1 = 2350$$
$$T_1 = 1175$$

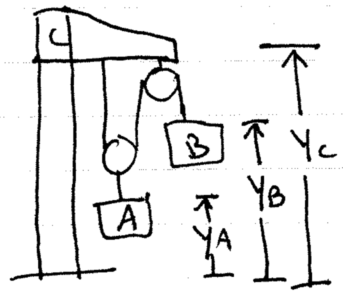
Assuming pulleys mass in very small
∴ $ma = 0$



$$T_1 - 60(9.8) - T_{AB} = 60(3.246)$$

$$\boxed{T_{AB} = 392\, N}$$

15.38



pulleys etc

$L = 2(y_C - y_A) + (y_C - y_B) + \text{constant}$

$= 3y_C - 2y_A - y_B$

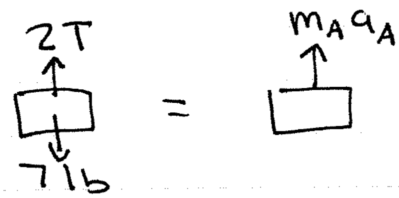
L does not change $\therefore \frac{dL}{dt} = 0$

$0 = 3V_C - 2V_A - V_B$

$0 = 3a_C - 2a_A - a_B$

$a_B = 3a_C - 2a_A$

Block A



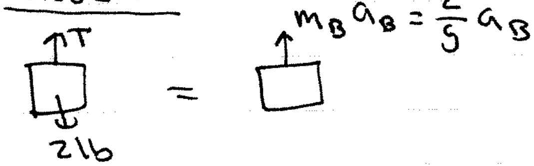
a_C given as $g/4$

① $a_B = \frac{3}{4}g - 2a_A$

$2T - 7 = \frac{7}{g} a_A$

$T = 3.5 + \frac{3.5}{g} a_A$ ②

Block B



$T - 2\,lb = \frac{2}{g} a_B$

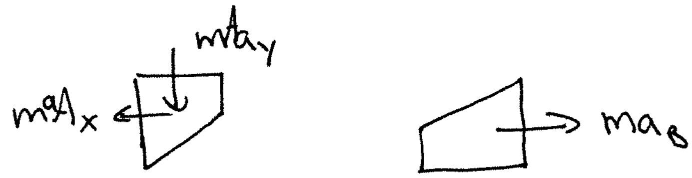
$T = 2 + \frac{2}{g} a_B$ ③

Set ② = ③ $\Rightarrow 3.5 + \frac{3.5}{g} a_A = 2 + \frac{2}{g} a_B$

$a_B = .75g + 1.75a_A$ ④

set ① = ④ $\Rightarrow \frac{3}{4}g - 2a_A = \frac{3}{4}g + 1.75a_A \Rightarrow \boxed{a_A = 0}$

Plug into ④ $\boxed{a_B = .75g}$ $\boxed{a_B = 24.15\,ft/s^2}$



15.44 Since no forces in x-direction

$a_{Ax} = a_B$ (1)

$a_A = a_B + a_{A/B}$ <u>Treat as vectors</u>

since A going down & left

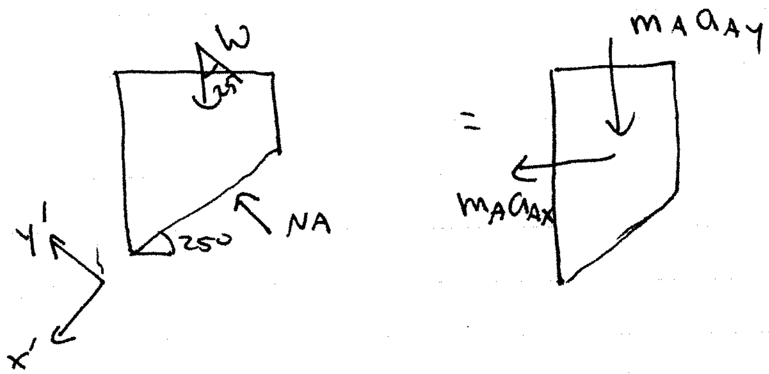
$-a_{Ax}\hat{\imath} - a_{Ay}\hat{\jmath} = a_B\hat{\imath} + a_{A/B}(-\cos 25\hat{\imath} - \sin 25\hat{\jmath})$

$\hat{\imath}$: $-a_{Ax} = a_B - a_{A/B}\cos 25$ (2) Plug in (1)

$\Rightarrow a_{A/B} = 2.207 a_B$

$\hat{\jmath}$: $-a_{Ay} = -a_{A/B}\sin 25$ (3) Plug in result of (2)

$\Rightarrow a_{Ay} = .9327 a_B$



$\Sigma F_{x'} = W\sin 25 = m_A a_{Ax}\cos 25 + m_A a_{Ay}\sin 25$

$W\sin 25 = \frac{W}{g} a_B \cos 25 + \frac{W}{g}(.9327 a_B)\sin 25$

$\boxed{a_B = .325g \rightarrow}$ Plug into result of (2)

$\boxed{a_{A/B} = .717g \swarrow}$

15.56 $U_{1-2} = T_2 - T_1$

$U_{1-2} = -\frac{1}{2}k(\delta_2^2 - \delta_1^2) - \mu N_A d_A - W_B d_B$

where $d_A = 3ft$ (distance block a moves)

$d_B = 1.5ft$ (distance block b moves up)

$N_A = W_A$ (since gravity is the only force in the y-direction on A)

$\delta_2 = 3ft$ (spring displacement) $\delta_1 = 0$

$T_2 = 0$ (Blocks at rest)

$T_1 = \frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2$ Note: $v_B = \frac{1}{2}v_A$

$-\frac{1}{2}k(9) - .4(6)(3) - 8(1.5) = -\frac{1}{2}\left[\frac{6}{32.2}(18^2) + \frac{8}{32.2}(9^2\right.$

$\Rightarrow$ $k = 4.68 \text{ lb/ft}$

15.62 $L_{1-2} = P_2 - P_1$ since no external forces $L_{1-2} = 0$

$\therefore P_2 = P_1$

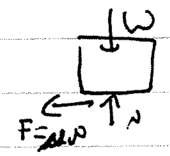
$P_1 = m_A v_0$

$P_2 = (m_A + m_B) v_2$

$$m_A v_0 = (m_A + m_B) v_2$$

$$v_2 = \frac{m_A}{(m_A + m_B)} v_0 = \frac{10}{10+15}(2.5) = 1 \text{ m/s}$$

Now apply work-energy to package



~~F = .25g~~

F = 2.5g

$U_{1-2} = T_2 - T_1$

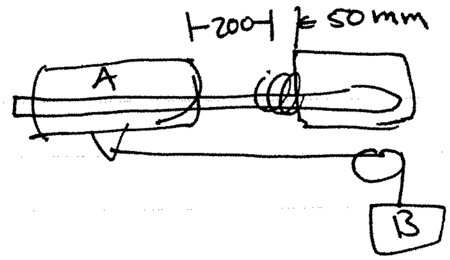
$U_{1-2} = -F x_{A/B}$

$$-F x_{A/B} = \frac{1}{2}(m_A + m_B) v_2^2 - \frac{1}{2} m_A v_0^2$$

$$-2.5g\, x_{A/B} = \frac{1}{2}(25)1^2 - \frac{1}{2}(10)(2.5)^2$$

$$\boxed{x_{A/B} = .765 \text{ m}}$$

15.64



$U_{1-2} = T_2 - T_1$ at rest at start and stop

$\therefore T_2 = T_1 = 0$

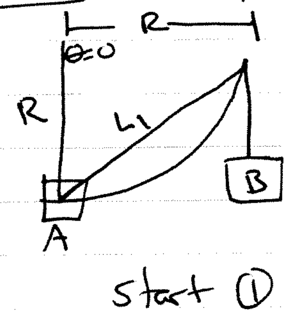
Gravity + spring do work

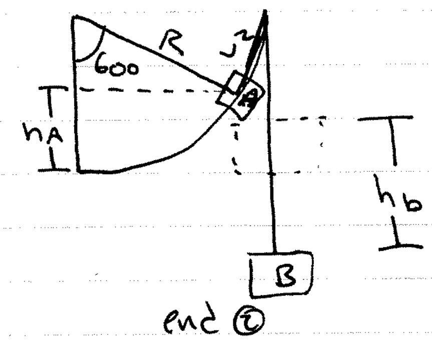
$$U_{1-2} = m_B g h - \frac{1}{2} k (\delta_2^2 - \delta_1^2) = 0$$

$$m_B = \frac{k}{2gh} (.05^2 - 0)$$

$$= \frac{200}{2(9.8)(1.25)} (.05)^2 = \boxed{.1019 \text{ kg} = m_B}$$

15.66 Only Forces doing work are gravity on A and on B





Also starts and stops at rest ∴ $T_1 = T_2 = 0$

$$U_{1-2} = 0 = -W_A h_A + W_B h_B$$

$$m_A g h_A = m_B g h_B$$

$$m_A h_A = m_B h_B$$

$$\frac{m_A}{m_B} = \frac{h_B}{h_A}$$

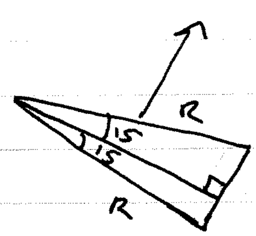
$$h_A = R - R\cos 60 = R(1-\cos 60)$$

$h_B = L_1 - L_2$ since rope has constant length

$$L_1 = R\sqrt{2}$$

$$L_2 = 2R\sin 15$$

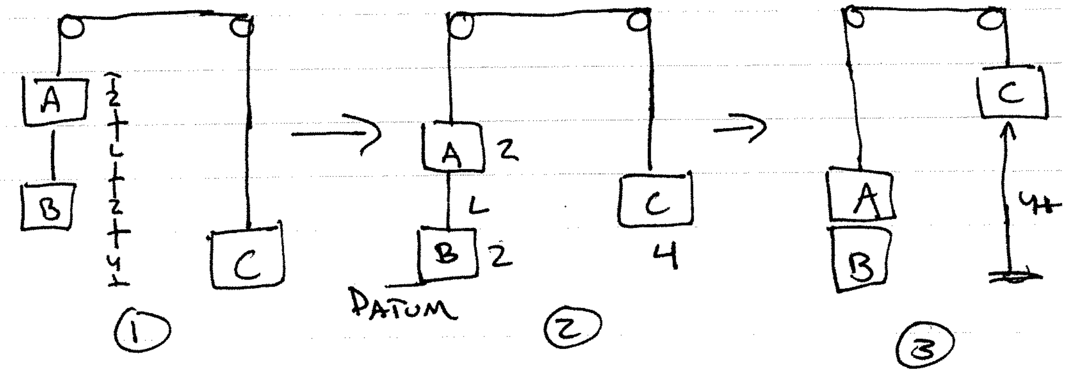
$\Big\}$ $h_B = R(\sqrt{2} - 2\sin 15)$



$$\frac{m_A}{m_B} = \frac{R(\sqrt{2} - 2\sin 15)}{R(1-\cos 60)} = 1.79$$

$$\boxed{\frac{m_A}{m_B} = 1.79}$$

15.68



When B hits the floor it no longer helps pull C up

$W_A = 50\,lb$
$W_B = 50\,lb$
$W_C = 80\,lb$

Conservation of Energy From 1-2

$V_1 + T_1 = V_2 + T_2$ $\qquad T_1 = 0$ starts at rest
$V_2 = 0$ at datum level

$$(W_A + W_B - W_C)(4) = 0 + \tfrac{1}{2}(m_A + m_B + m_C)v_2^2$$

$$80 = \frac{90}{32.2} v_2^2$$

$$v_2 = 5.35\,ft/s$$

Conservation of Energy From 2-3

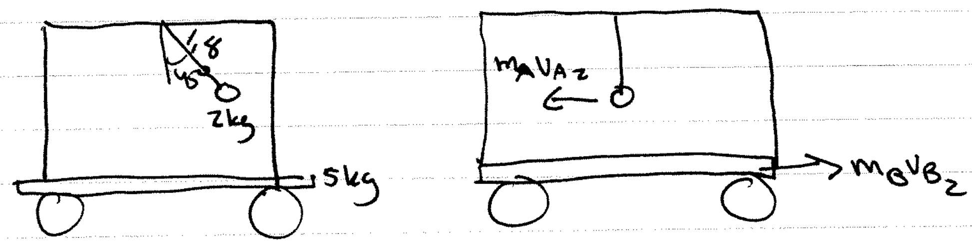
$V_2 + T_2 = V_3 + T_3$ $\qquad T_3 = 0$ at rest
$V_2 = 0$ still at datum

$$0 + \tfrac{1}{2}(m_A + m_C)v_2^2 = (-50 + 80)L + 0$$

(-50 ← m_A, 80 ← m_C)

$$L = 1.93\,ft$$

15.72 No horizontal forces acting on the system $\therefore (P_1)_x = (P_2)_x = 0$ since system starts at re



$$(P_x)_2 = -m_A v_{A2} + m_B v_{B2} = 0$$

$$V_{B2} = \frac{2}{5} v_{A2}$$

From work energy

$$U_{1-2} = T_2 - \cancel{T_1}^{\,0}$$

0 starts at rest

only force doing work is weight of the bob

$$m_A g h = \frac{1}{2} m_A v_{A_2}^2 + \frac{1}{2} m_B v_{B_2}^2$$

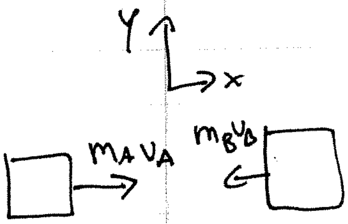
$$h = 1.8(1-\cos 45)$$

$$2(9.8)(1.8)(1-\cos 45) = \frac{1}{2}(2) v_{A_2}^2 + \frac{1}{2}(5)\left(\frac{2}{5} v_{A_2}\right)^2$$

$$V_{A_2} = 2.72 \leftarrow$$

$$\therefore V_{B2} = 1.087 \text{ m/s} \rightarrow$$

15.78 No external forces acting on system



$\therefore (P_x)_1 = (P_x)_2$

Starts at rest $\therefore$ $(P_x)_1 = (P_x)_2 = 0$

$$(P_x)_2 = m_A V_{A2} - m_B V_{B2} = 0$$

$$V_{A2} = V_{B2}\left(\frac{m_B}{m_A}\right) = 2V_{B2}$$

since $V_A = 2V_B$, **block A hits first**

Conservation of Energy

$V_1 + T_1 = V_3 + T_3$ Where ① is the start
③ just before impact

since $V_A = 2V_B$ when Block A is at position C, Block B is still 6in away $\therefore$ spring unstretched at position ③ $\therefore V_3 = 0$

$T_1 = 0$ since starts at rest

$$\tfrac{1}{2} k \delta_1^2 + 0 = 0 + \tfrac{1}{2}\left[m_A V_{A3}^2 + m_B V_{B3}^2\right]$$

$$\delta = 2ft - .5ft = 1.5ft$$

$$\tfrac{1}{2}(12)(1.5) = \tfrac{1}{2}\left[\frac{24}{g} V_{A3}^2 + \frac{48}{g}\left(\tfrac{1}{2} V_{A3}\right)^2\right]$$

$$\boxed{V_{A3} = 4.91 ft/s}$$