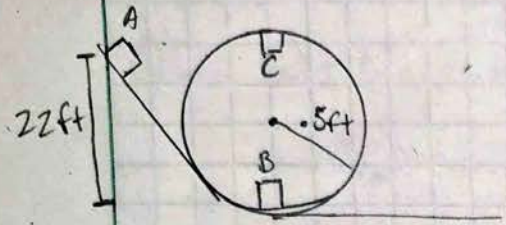
Prob #1 $W = 31b$ $h_A = 22ft$ $r = .5\,ft$



$T_1 + V_1 = T_2 + V_2$ or $T_A + V_A = V_B + T_B$

$T_A = \frac{1}{2} m V_A^2 = \frac{1}{2} \cdot \frac{3}{32.2} \cdot 0^2 = 0$

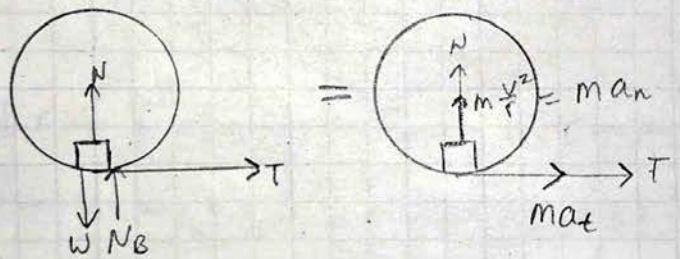
$V_A = 31b \cdot 22ft = 6616\text{-}ft$

$T_B = \frac{1}{2} m V_B^2 = \frac{1}{2} \cdot \frac{3}{32.2} V_B^2 = 4.65 \times 10^{-2} V_B^2$

$V_B = W h_B = 31b \cdot 0ft = 0$

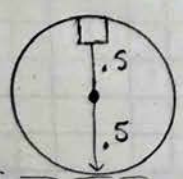
$0 + 6616\text{-}ft = 4.65 \times 10^{-2} V_B^2 + 0$

$V_B = \sqrt{\frac{6616\text{-}ft}{4.65 \times 10^{-2} \frac{lb}{ft/s^2}}} = 37.64\ ft/s$



Q1 $-W + N_B = m a_n$

$N_B = W + m\frac{V_B^2}{r} = 31b + \frac{3}{32.2}\left(\frac{(37.64\ ft/s)^2}{.5}\right) = \boxed{2671b}$



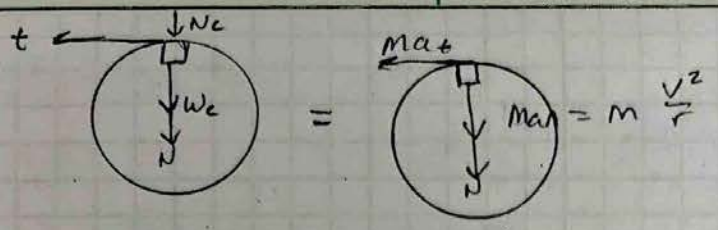
$T_A + V_A = T_C + V_C$

$T_C = \frac{1}{2} m V_C^2 = \frac{1}{2} \cdot \frac{3}{32.2} V_C^2 = 4.65 \times 10^{-2} V_C^2$

$V_C = W h_C = 31b \cdot 1ft = 31b\text{-}ft$

$0 + 6616\text{-}ft = 4.65 \times 10^{-2} V_C^2 + 31b\text{-}ft$

$V_C = \sqrt{\frac{6616\text{-}3\,1b\text{-}ft}{4.65 \times 10^{-2} \frac{lb}{ft/s^2}}} = 36.77\ ft/s$



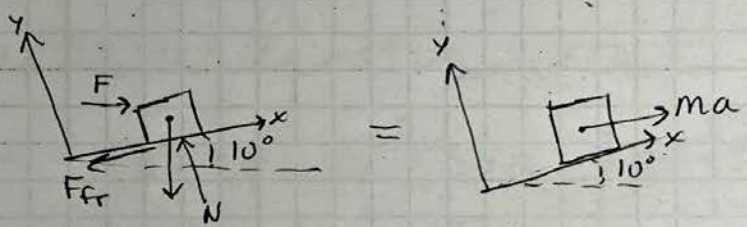
Q2. $W + N_c = ma_n$

$$N_c = -W + m\frac{v_c^2}{r} = -316 + \left(\frac{3}{32.2}\right)\left(\frac{(36.77 ft/s)^2}{.5 ft}\right)$$

$$\boxed{N_c = 2491 lb}$$

Problem #2 $m = 100 kg$ $F = 500 N$ $\mu_k = .3$ $\alpha = 10°$ $t = 20 s$

Q3.



X dir: $F\cos\alpha - F_{fr} - W\sin\alpha = ma$

Y dir: $-W\cos\alpha - F\sin\alpha + N = 0$

$F_{fr} = \mu_k N = \mu_k (W\cos\alpha + F\sin\alpha)$

$N = W\cos\alpha + F\sin\alpha$

$F\cos\alpha - \mu_k(W\cos\alpha + F\sin\alpha) - W\sin\alpha = ma$

$$a = \frac{F\cos\alpha - \mu_k(W\cos\alpha + F\sin\alpha) - W\sin\alpha}{m}$$

$$a = \frac{500\cos 10 - (.3\cdot(100\cdot 9.81\cdot\cos 10 + 500\sin 10) - 100\cdot 9.81\sin 10}{100 kg}$$

$a = .0617 m/s^2$

$V = V_0 + at = 0 + .0611 m/s^2 \cdot 20 s = 1.2357 m/s$

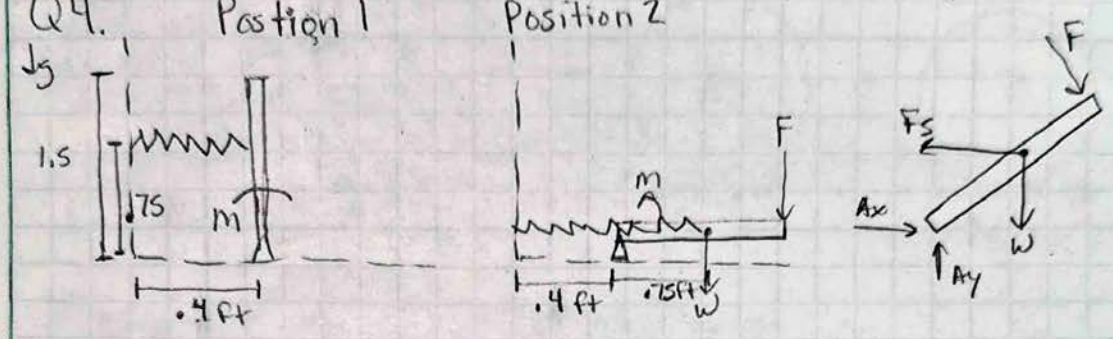
$P = F\cos\alpha \cdot V = 500 N \cdot \cos 10 \cdot 1.2357 m/s = \boxed{608.499 W}$

Problem #3

$W = 25\ lb \quad L = 1.5\ ft \quad m = 5\ lb\text{-}ft \quad F = 30\ lb$

$K = 12\ lb/ft \quad l_0 = .2\ ft \quad d = .4\ ft$

Q4.



$U_{1\to2} = U_{F,1\to2} + U_{W,1\to2} + U_{F_s,1\to2} + U_{m,1\to2}$

$U_{F,1\to2} = F\Delta S = F\,\frac{1}{2}\pi r = 30\,lb \cdot \frac{1}{2}\pi \cdot 1.5\,ft = 70.685\ lb\text{-}ft$

$U_{W,1\to2} = W \cdot \frac{L}{2} = 25\,lb \cdot \frac{1.5\,ft}{2} = 18.75\ lb\text{-}ft$

$U_{FS,1\to2} = -\frac{1}{2}K\left(x_2^2 - x_1^2\right) = -\frac{1}{2}(12)(.95^2 - .2^2) = -5.175\ lb\text{-}ft$

$x_1 = .4 - .2 = .2\ ft$

$x_2 = .2 + \frac{1.5}{2} = .95\ ft$

$U_{m,1\to2} = -m\Delta\theta = -5\,lb\text{-}ft \cdot \frac{\pi}{2} = -7.854\ lb\text{-}ft$

$U_{1\to2} = 70.685 + 18.75 - 5.175 - 7.854 = 76.406\ lb\text{-}ft$

$T_1 + U_{1\to2} = T_2 \qquad 0 + 76.406 = \omega_2^2 \cdot .2911$

$T_1 = 0$

$T_2 = \frac{1}{2}mV_2^2 + \frac{1}{2}I\omega_2^2 = \frac{1}{2}m\left(\frac{L}{2}\omega_2\right)^2 + \frac{1}{2}mL^2\omega_2^2 \cdot \frac{1}{12} = \frac{1}{6}mL^2\omega_2^2$

$I = \frac{1}{12}mL^2 \qquad T_2 = \frac{1}{6} \cdot \frac{25}{32.2} \cdot 1.5^2 \cdot \omega_2^2 = .2911\,\omega_2^2$

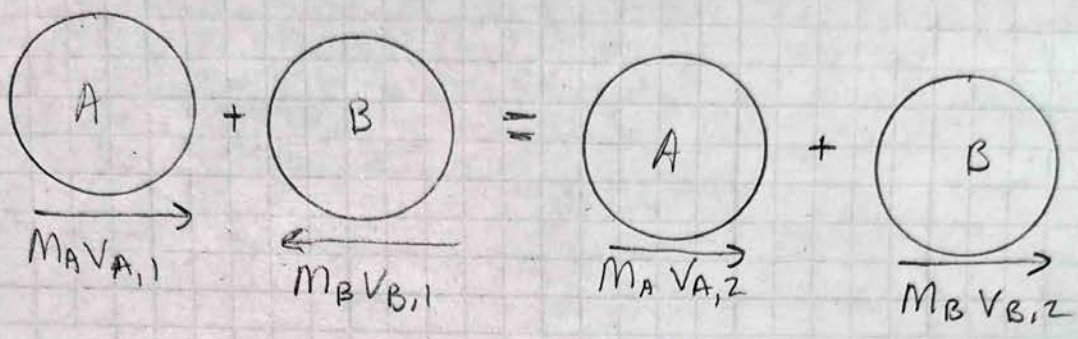
$V_2 = \frac{L}{2}\omega_2$

$\omega_2 = \sqrt{\frac{76.406}{.2911}} = \boxed{16.1997\ rad/s}$

Problem 4 $W_A = 5\,lb$ $W_B = 10\,lb$ $e = .8$

$V_{A1} = 4\,ft/s$ $V_{B1} = 2\,ft/s$

$V_{A,2} = ?$ $V_{B,2} = ?$ $E_{LOSS} = ?$



$$m_A v_{A,1} + m_B v_{B1} = m_A v_{A2} + m_B v_{B2}$$

$$v_{B2} - v_{A2} = e(v_{A1} - v_{B1})$$

$$\frac{\frac{w_A}{g} v_{A1} + \frac{w_B}{g} v_{B,1} = \frac{w_A}{g} v_{A,2} + \frac{w_B}{g} v_{B,2}}{g}$$

$$w_A v_{A,1} + w_B v_{B1} = w_A v_{A,2} + w_B v_{B2}$$

$$5\,lb \cdot 4\,ft/s + 10\,lb \cdot (-2\,ft/s) = 5 v_{A2} + 10 v_{B2}$$

20 $\quad -20$

$$\frac{0 = 5 v_{A2} + 10 v_{B2}}{5}$$

$$v_{A2} + 2 v_{B2} = 0$$

$$v_{B2} - v_{A2} = .8(4 - (-2))$$

$$-v_{A2} + v_{B2} = 4.8 \qquad -v_{A2} + 1.6 = 4.8$$

$$+ (v_{A2} + 2 v_{B2} = 0) \qquad \text{Q5)} \quad \boxed{v_{A2} = -3.2\ ft/s}$$

$$0 + 3 v_{B2} = 4.8$$

Q6) $\boxed{v_{B2} = 1.6\ ft/s}$

Q7 $E_{LOSS} = \sum T_{i,1} - \sum T_{i,2}$

$E_{LOSS} = \left(\frac{1}{2} m_A v_{A_1}^2 + \frac{1}{2} m_B v_{B,1}^2\right) - \left(\frac{1}{2} m_A v_{A,2}^2 + \frac{1}{2} m_B v_2^2\right)$

$= \left(\frac{1}{2} \cdot \frac{5}{32.2} \cdot 4^2 + \frac{1}{2} \frac{10}{32.2} (-2)^2\right) + \left(\frac{1}{2} \cdot \frac{5}{32.2} \cdot (-3.2)^2 + \frac{1}{2} \frac{10}{32.2} (1.6)^2\right)$

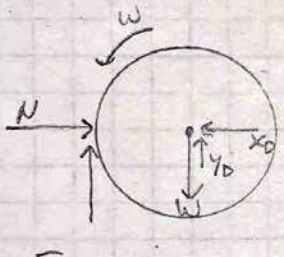
$= \boxed{.6708 \text{ lb-ft}}$

Problem 5

$r = 12$ in $\quad I = 20.5$ lb-ft-s^2 $\quad L_1 = 5$ in, $L_2 = 16$ in, $L_3 = 6$ in

$\mu_s = .4 \quad \mu_k = .3$

$\omega_1 = 350 \text{ RPM} \cdot \frac{2\pi \cdot 1 \text{ min}}{60 \text{ s}} = 11.66\pi \text{ rad/s}$



$F = \mu N$

$N = \frac{43.8246 N}{.3}$

$N = 146.08$ lb

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

$T_1 = \frac{1}{2} I \omega_1^2 = \frac{1}{2} \cdot 20.5 \cdot (11.66\pi)^2 = 13767.9$ ft-lb

$\omega_2 = 0 \quad \therefore T_2 = 0$

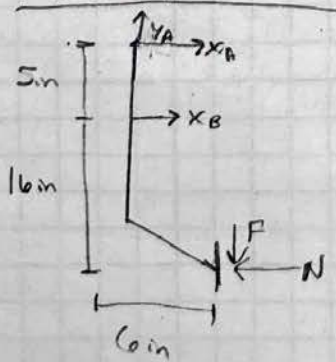
$\theta = 50 \text{ rev} = 50 \cdot 2\pi = 100\pi \text{ rad}$

$U_{1-2} = -M\theta = -\left(F\left(\frac{12 \text{ in}}{12 \frac{\text{in}}{\text{ft}}}\right) \cdot (100\pi) = -314.16 F\right.$

$13767.9 - 314.16 F = 0$

$F = \frac{-13767.9}{-314.16} = 43.8246 N$

FBD Brake Arm



$+\circlearrowleft \sum M_A = 0$

$X_B \cdot 5 - F \cdot 6 - N \cdot 21 = 0$

$X_B = \frac{(43.8246) \cdot 6) + (146.08 \cdot 21)}{5}$

Q8

$\boxed{X_B = 666.133 \text{ lb}}$

Q9. $+\circlearrowleft \Sigma M_A = 0$

$X_B \cdot 5 + F \cdot 6 - N \cdot 21 = 0$

$$X_B = \frac{(146.08 \cdot 21) - (43.8246 \cdot 6)}{5} = \boxed{560.9516}$$