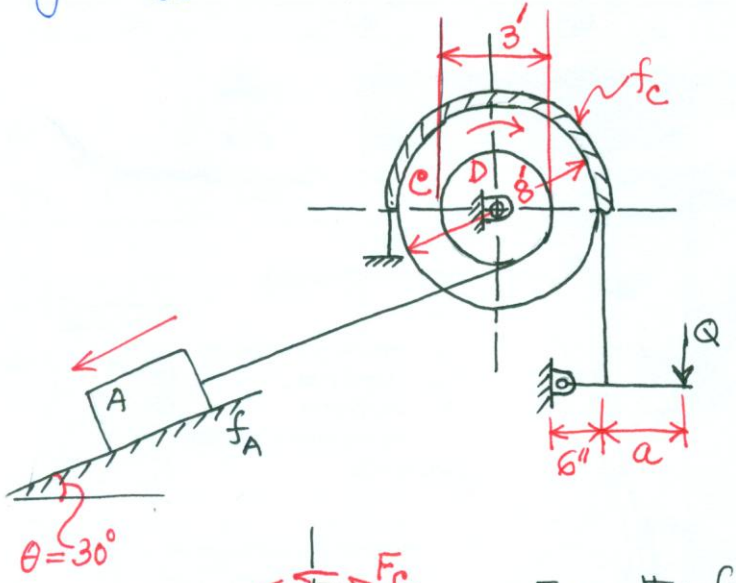
1424/P. 420

(Using Energy Principle)



$W_{CD} = 2576$ lb

$\bar{k}_{CD} = 3$ ft

$W_A = 2000$ lb

$f_A = 1/3$

$v_{A0} = 40$ fps, $v_{Af} = 10$ fps

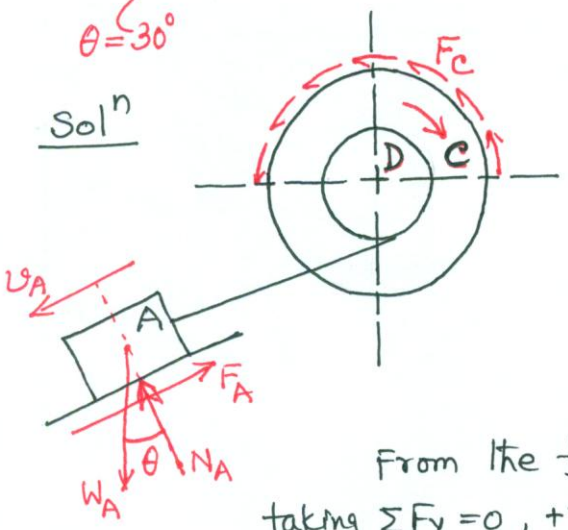
$S_A = 170$ ft

$f_C = 0.25$

$a = 30''$

$Q = ?$

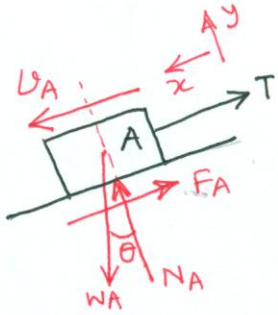
Sol^n



From the freebody shown on left

$$U_{net} = (W_A \sin\theta - F_A) \times S_A - F_C \times S_C \quad \text{---(1)}$$

$$\Delta KE = \frac{1}{2}\cdot\frac{W_A}{g}\left(v_{Af}^2 - v_{A0}^2\right) + \frac{1}{2}\bar{I}_{CD}\left(\omega_{CDf}^2 - \omega_{CD0}^2\right) \quad \text{---(2)}$$



From the freebody of A

taking $\Sigma F_y = 0$, +ve y direct^n as +ve

$$N_A - W_A \cos\theta = 0$$

$$\therefore N_A = 2000 \cos 30^\circ = 1732.05 \text{ lb}$$

$$\therefore F_A = N_A \cdot f_A = 1732.05 \times \frac{1}{3} = 577.35 \text{ lb}$$

Considering the circular displacement of points on C & D and on the same radial line —

$$\text{rotation, } \theta = \frac{S_D}{r_D} = \frac{S_C}{r_C}$$

$$\Rightarrow \frac{S_A}{1.5} = \frac{S_C}{4}$$

$$\therefore S_C = S_A \times \frac{4}{1.5} = 170 \times \frac{4}{1.5} = 453.33 \text{ ft}$$

Now substituting known quantities in eq^n (1)

$$U_{net} = (2000 \sin 30^\circ - 577.35) \times 170 - F_C \times 453.33$$

$$= 71850.5 - 453.33\, F_C \quad \text{---(3)}$$

Contd---

#1424/P.420 Contd--

$$\bar{I}_{CD} = m_{CD}\bar{k}_{CD}^2 = \frac{W_{CD}}{g}\bar{k}_{CD}^2 = \frac{2576}{32.2}\times 3^2 = 720 \text{ slug-ft}^2$$

$$\omega_{CDf} = \frac{v_{Af}}{r_D} = \frac{10}{1.5} = \quad \text{rad/s}$$

$$\omega_{CDo} = \frac{v_{Ao}}{r_D} = \frac{40}{1.5} = 26.67 \text{ rad/s}$$

Now from eqn (2)

$$\Delta KE = \frac{1}{2}\frac{2000}{32.2}\times\left(10^2 - 40^2\right) + \frac{1}{2}\times 720\times\left(6.67^2 - 26.67^2\right)$$

$$= -46583.85 - 240048$$

$$= -286631.85 \text{ ft-lb} \quad \text{——} (4)$$

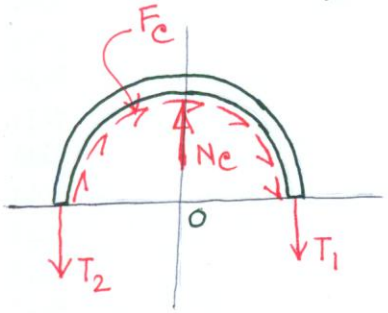
According to principles of work and energy

$$U_{net} = \Delta KE$$

$\therefore$ Equating (3) & (4)

$$71850.5 - 453.33F_c = -286631.85$$

$$\therefore F_c = 790.78 \text{ lb}$$



From the freebody of the brake band

$$T_2 = T_1 e^{f\theta_1} = T_1 e^{0.25\times\pi} = 2.19\,T_1$$

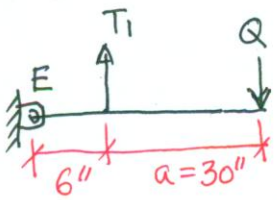
Taking $\Sigma M_O = 0$ ↷ +ve

$$T_1\times 4 + F_c\times 4 - T_2\times 4 = 0$$

$$\Rightarrow T_1 + F_c - T_2 = 0$$

$$\Rightarrow T_1 + 790.78 - 2.19T_1 = 0$$

$$\therefore T_1 = 664.52 \text{ lb}$$



From the freebody of brake lever considering $\Sigma M_E = 0$ ↷ +ve

$$-T_1\times 6 + Q\times 36 = 0$$

$$\Rightarrow -664.52\times 6 + Q\times 36 = 0$$

$$\therefore Q = \boxed{110.75 \text{ lb}} \text{ Ans.}$$