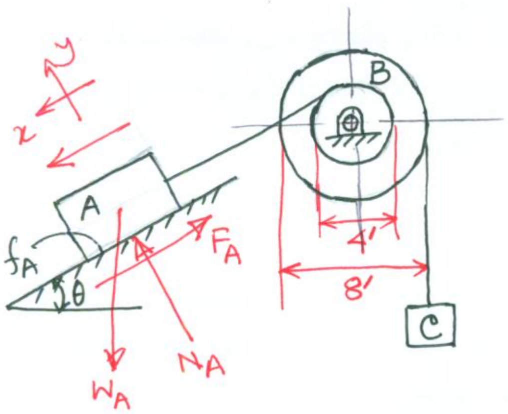
#1292/P.379 (Using Energy Principle)



Sol^n From the freebody of the entire system

$$U_{net} = (W_A \sin\theta - F_A) \cdot S_A - W_C \cdot S_C$$

$$= (12880 \sin 30^\circ - 2788.6) \times 100 - W_C \times 200$$

$$= 365140 - 200\, W_C \quad \text{(lb-ft)}$$

$$S_C = \theta_B \cdot r_C = \frac{S_A}{r_A} \times r_C = \frac{100}{2} \times 4 = 200 \text{ ft}$$

From freebody of B, $\Sigma F_y = 0$ gives $N_A = W_A \cos\theta$

$$\therefore F_A = N_A \cdot f_A = W_A \cos\theta \cdot f_A = 12880 \times \cos 30^\circ \times \frac{1}{4} = 2788.6 \text{ lb}$$

$$\Delta KE = \frac{1}{2}\frac{W_A}{g} v_A^2 + \frac{1}{2}\frac{W_C}{g} v_C^2 + \frac{1}{2}\bar{I}_B \omega_B^2$$

$$S_A = \frac{1}{2} a_A t^2 \Rightarrow 100 = \frac{1}{2} \times a_A \times 40^2 \quad \therefore a_A = 0.125 \text{ fps}^2$$

$$v_A = a_A t = 0.125 \times 40 = 5 \text{ fps}$$

$$v_C = r_C \omega_B = r_C \times \frac{v_A}{r_A} = 4 \times \frac{5}{2} = 10 \text{ fps}$$

$$\bar{I}_B = \bar{k}_B^2 m_B = \bar{k}_B^2 \cdot \frac{W_B}{g} = 3^2 \times \frac{6440}{32.2} = 1800 \text{ slug-ft}^2$$

$$\omega_B = \frac{v_A}{r_A} = \frac{5}{2} = 2.5 \text{ rad/s}$$

substituting the above quantities,

$$\Delta KE = \frac{1}{2} \times \frac{12880}{32.2} \times 5^2 + \frac{1}{2} \times \frac{W_C}{32.2} \times 10^2 + \frac{1}{2} \times 1800 \times 2.5^2$$

$$= 5562.5 + 1.553\, W_C \quad \text{(lb-ft)}$$

Now $U_{net} = \Delta KE$

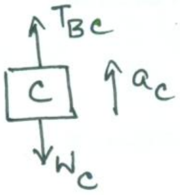
$$\Rightarrow 365140 - 200\, W_C = 5562.5 + 1.553\, W_C$$

$$\therefore W_C = 1784 \text{ lb}$$

contd....

#1292/P.379 contd..

Using Energy Principle



$$\omega_B = \frac{v_A}{r_A} = \frac{v_C}{r_C}$$

$$\Rightarrow \frac{a_A t}{r_A} = \frac{a_C t}{r_C}$$

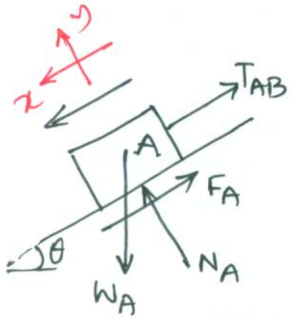
$$\therefore a_C = a_A \times \frac{r_C}{r_A} = 0.125 \times \frac{4}{2} = 0.25 \text{ fps}^2$$

$$\Sigma F_V = m_C a_C \uparrow +ve$$

$$\Rightarrow T_{BC} - W_C = \frac{W_C}{g} \times a_C$$

$$\Rightarrow T_{BC} - 1784 = \frac{1784}{32.2} \times 0.25$$

$$\therefore T_{BC} = 1797.85 \text{ lb.}$$



$$\Sigma F_x = m_A a_A$$

$$\Rightarrow W_A \sin\theta - T_{AB} - F_A = \frac{W_A}{g} \cdot a_A$$

$$\Rightarrow 12880 \sin 30^\circ - T_{AB} - 2788.6 = \frac{12880}{32.2} \times 0.125$$

$$\therefore T_{AB} = 3601.4 \text{ lb.}$$

Note: After obtaining W_C, ~~F_{BC}~~ from $U_{net} = \Delta KE$, T_{BC} can be obtained from the free body of C or. T_{AB} can be obtained from the freebody of A and then the other T ~~(ie~~ can be obtained from the freebody of B using $\Sigma M_B = \bar{I}_B \alpha_B$.

$$\Sigma M_B = \bar{I}_B \alpha_B \curvearrowleft +ve$$

$$\Rightarrow T_{AB} \times 2 - T_{BC} \times 4 = \bar{I}_B \times \frac{a_A}{r_A}$$