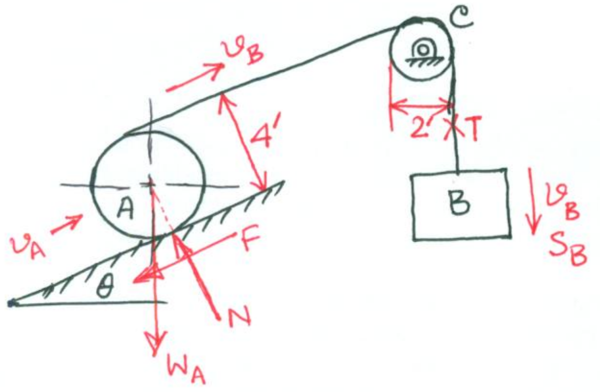
1449/P.422



$W_B = 50$ lb
$W_A = 80$ lb
$\theta = 30^\circ$
$\bar{I}_A = 4$ slug-ft^2
$S_B = 20$ ft
$\bar{I}_c = 0{\cdot}3$ slug-ft^2
$v_A = ?$ $v_A \rightarrow$ velocity of c.g. of A
$T = ?$ $a_B = ?$

Sol^n

For the entire system,

$$U_{net} = W_B \cdot S_B - W_A \sin\theta \cdot S_A \quad \text{——} (1)$$

$$\Delta KE = \frac{1}{2}\frac{W_B}{g}v_B^2 + \frac{1}{2}\cdot\frac{W_A}{g}v_A^2 + \frac{1}{2}\bar{I}_A\omega_A^2 + \frac{1}{2}\bar{I}_c\omega_c^2 \quad \text{——} (2)$$

Note: Since A is rolling, friction force F does no work. Art. 280/P.401.

Now $\frac{v_B}{v_A} = \frac{4}{2} = 2$

$\therefore v_B = 2v_A$

$\therefore S_B = 2S_A$ ie $S_A = \frac{S_B}{2} = \frac{20}{2} = 10$ ft

$\omega_A = \frac{v_A}{r_A} = \frac{v_A}{2}$

$\omega_c = \frac{v_B}{r_c} = \frac{v_B}{1} = v_B = 2v_A$

Note: Because of rolling, the instantaneous center is the point of contact and velocity of any other point is proportional to the distance from instanteneous center. Art. 198/PP271-273, Art 199/P.274

From eq^n (1), $U_{net} = 50 \times 20 - 80 \sin 30^\circ \times 10 = 600$ lb-ft

& From eq^n (2), $\Delta KE = \frac{1}{2}\cdot\frac{50}{32{\cdot}2}(2v_A)^2 + \frac{1}{2}\cdot\frac{80}{32{\cdot}2}v_A^2 + \frac{1}{2}\cdot 4\cdot\left(\frac{v_A}{2}\right)^2 + \frac{1}{2}\times 0{\cdot}3 \times (2v_A)^2$

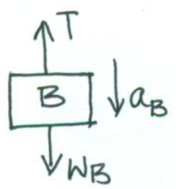
$= 5{\cdot}448\, v_A^2$ lb-ft

According to the principles of work and kinetic energy

$U_{net} = \Delta KE$

$\Rightarrow 600 = 5{\cdot}448\, v_A^2$ $\quad\therefore v_A = \boxed{10{\cdot}5 \text{ fps}}$ Ans.

& $v_B = 2v_A = 2 \times 10{\cdot}5 = 21$ fps.



Considering the motion of body B

$v_B^2 = 2a_B S_B$ ie $a_B = \frac{v_B^2}{2S_B} = \frac{21^2}{2\times 20} = \boxed{11{\cdot}03 \text{ fps}^2}$ Ans

Taking $\Sigma F_y = m_B a_B \downarrow +ve$

$W_B - T = \frac{W_B}{g}\cdot a_B$

$\therefore T = W_B - \frac{W_B}{g}\cdot a_B = 50 - \frac{50}{32{\cdot}2}\times 11{\cdot}03 = \boxed{32{\cdot}87 \text{ lb}}$ Ans.