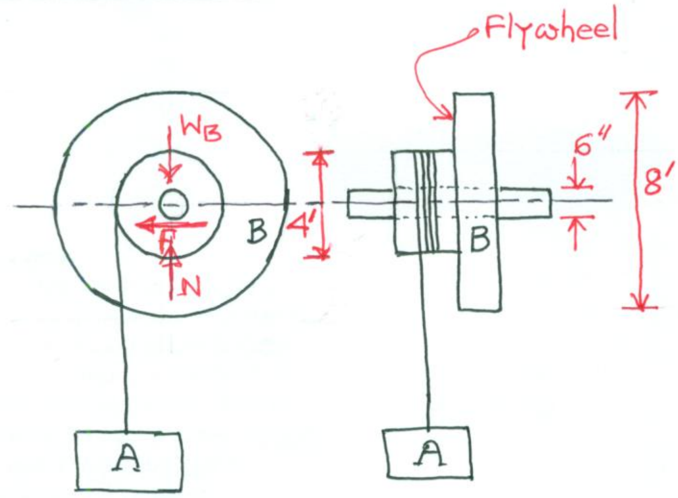
Ex. 278 / PP. 398 - 399



$W_B = 1288$ lb

$\bar{k}_B = 2.5$ ft

$S_A = 80$ ft ↓

$\omega_1 = 10$ rpm $= \frac{10 \times 2\pi}{60}$ rad/s $= 1.047$ rad/s

$\omega_2 = 120$ rpm $= \frac{120 \times 2\pi}{60}$ rad/s $= 12.566$ rad/s

$F = 70$ lb

$W_A = ?$

Sol^n

U_{net} = Work done by body A to move down − Work done against friction

$= W_A \cdot S_A - F \cdot r\theta$ | $r = \frac{3}{12}$ ft, $\theta = \frac{S_A}{2} = \frac{80}{2} = 40$ rad

$= W_A \times 80 - 70 \times \frac{3}{12} \times 40$

$= 80 W_A - 700$ ft-lb

$$\Delta KE = \frac{1}{2} \cdot \frac{W_A}{g}(v_2^2 - v_1^2) + \frac{1}{2} I_O (\omega_2^2 - \omega_1^2)$$

$$= \frac{1}{2} \times \frac{W_A}{32.2} \times (25.13^2 - 2.09^2) + \frac{1}{2} \times 250 \times (12.566^2 - 1.047^2)$$

$$= 9.738 W_A + 19601 \text{ ft-lb}$$

$v_1 = r_A \omega_1 = 2 \times 1.047 = 2.09$ fps

$v_2 = r_A \omega_2 = 2 \times 12.566 = 25.13$ fps

$I_O = m_B \bar{k}_B^2 = \frac{1288}{32.2} \times 2.5^2$ slug-ft^2 $= 250$ slug-ft^2

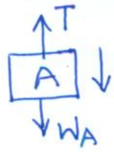
According to the principles of work and kinetic energy

$U_{net} = \Delta KE$

$\Rightarrow 80 W_A - 700 = 9.738 W_A + 19601$

$\therefore W_A = $ **288.94 lb** Ans.

Alternative sol^n: This problem can also be solved by considering freebody of component parts.



Applying 'work done = ΔKE' for body A

$$(W_A - T) \times S_A = \frac{W_A}{2g}(v_1^2 - v_2^2) \quad \text{--- (1)}$$

Applying 'work done = ΔKE' for rotating part B

$$M_O \theta = \frac{I_O}{2}(\omega_2^2 - \omega_1^2)$$

$$\Rightarrow T \times 2 - F \times \frac{3}{12} = \frac{I_O}{2}(\omega_2^2 - \omega_1^2) \quad \text{--- (2)}$$

In eq^{n}s (1) & (2) there are two unknowns T & W_A, so can be solved.