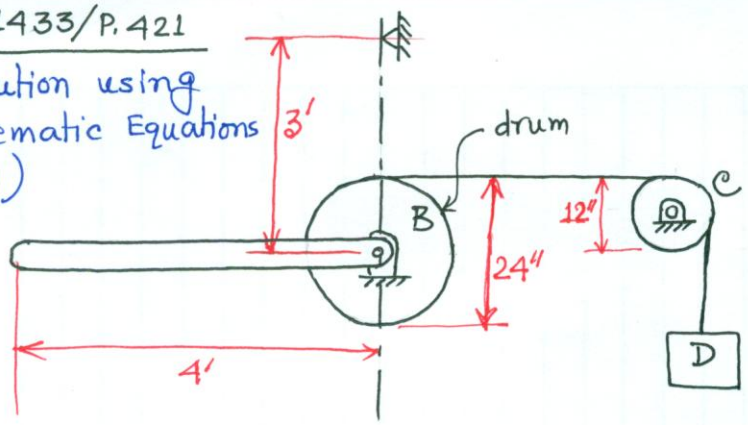
1433/P. 421

(Solution using Kinematic Equations only)

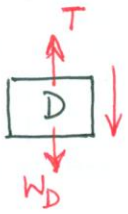


$W_A = 48.3$ lb
$W_B = 128.8$ lb
$\bar{k}_B = 10$ inch
$W_D = 644$ lb
Start from rest
$\theta_B = \theta_A = \frac{\pi}{2}$ rad.

(a) K.E. = ? when A strikes Q

(b) v_D = ?

Soln



From the freebody of D

$\Sigma F_V = m_D a_D \downarrow +ve$

$\Rightarrow W_D - T = \frac{W_D}{g} \cdot a_D$

$\Rightarrow 644 - T = \frac{644}{32.2} \times \frac{v_D^2}{\pi}$

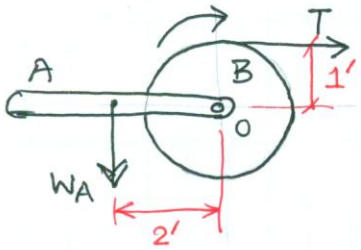
$\Rightarrow 644 - T = 6.37\, v_D^2$ —— (1)

$v_D^2 = 2 a_D s_D$

$s_D = r_B \theta_B = 1 \times \frac{\pi}{2} = \frac{\pi}{2}$ ft

$\therefore v_D^2 = 2 a_D \times \frac{\pi}{2}$

i.e. $a_D = \frac{v_D^2}{\pi}$



From the freebody of drum B taking $\Sigma M_O = I_O \alpha_{AB} \curvearrowright +ve$

$\Rightarrow T \times 1 - W_A \times 2 = I_O \alpha_{AB}$ —— (2)

Now $I_O = I_{AO} + I_{BO}$

$= \frac{1}{3} m_A L_A^2 + m_B k_B^2$

$= \frac{1}{3} \times \frac{48.3}{32.2} \times 4^2 + \frac{128.8}{32.2} \times \left(\frac{10}{12}\right)^2$

$= 8 + 2.78$

$= 10.78$ slug-ft^2

$\omega_{ABf} = \frac{v_D}{r_B} = \frac{v_D}{1} = v_D$

$\omega_{ABf}^2 = \omega_{ABO}^2 + 2 \alpha_{AB} \theta_{AB}$

$\Rightarrow v_D^2 = 0 + 2 \cdot \alpha_{AB} \cdot \frac{\pi}{2}$

$\therefore \alpha_{AB} = \frac{v_D^2}{\pi}$

$\therefore$ From eqn (2) $T \times 1 - 48.3 \times 2 = 10.78 \times \frac{v_D^2}{\pi}$

$\Rightarrow T - 966.6 = 3.43 v_D^2$ —— (3)

Adding eqns (1) & (3) $547.4 = 9.8\, v_D^2 \Rightarrow v_D =$ **7.47 fps**

$\therefore$ kE. when A strikes Q = 4 KE $= \frac{1}{2} \frac{W_D}{g} v_D^2 + \frac{1}{2} I_O \omega_{ABf}^2$

$= \frac{1}{2} \frac{W_D}{g} \cdot v_D^2 + \frac{1}{2} I_O v_D^2 = \frac{1}{2}\left(\frac{644}{32.2} + 10.78\right) \times 7.47^2 = 858.8$ lb-ft