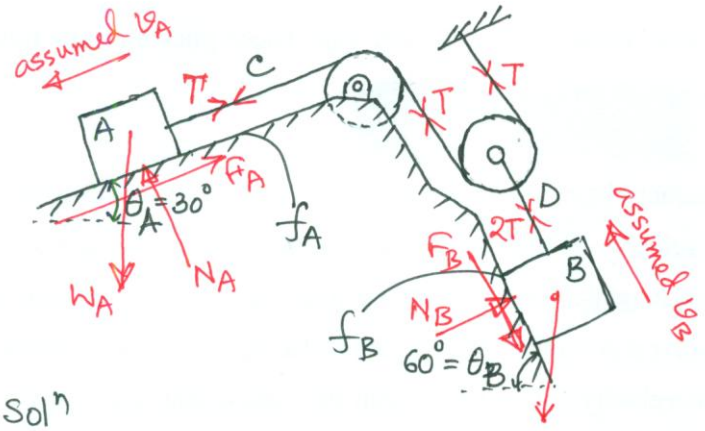
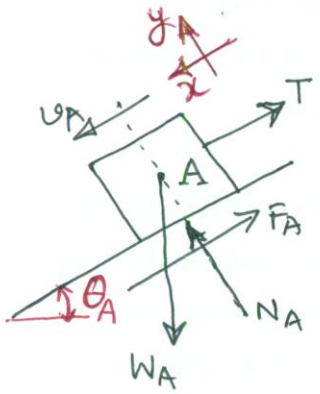
1138/P. 328 (Using Energy Principle)



$W_A = 200$ lb
$W_B = 100$ lb
$f_A = \frac{1}{4}$, $f_B = \frac{1}{3}$
$S_A = ?$ in 30 sec./direct^n ?
$T_C = ?$
$T_D = ?$
Initially at rest

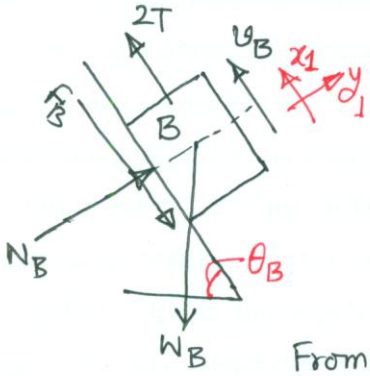
Soln

Let us assume that body A moves downward.



From the freebody of A taking $\Sigma F_y = 0$ +ve y direct^n as +ve

$$N_A - W_A \cos\theta_A = 0$$
$$\Rightarrow N_A - 200 \cos 30^\circ = 0$$
$$\therefore N_A = 173.2 \text{ lb}$$
$$\therefore F_A = N_A \cdot f_A = 173.2 \times \frac{1}{4} = 43.3 \text{ lb}$$



From the freebody of B, $\Sigma F_{y_1} = 0$ gives

$$N_B - W_B \cos\theta_B = 0$$
$$\therefore N_B = 100 \times \cos 60^\circ = 50 \text{ lb}$$
$$\therefore F_B = N_B \cdot f_B = 50 \times \frac{1}{3} = 16.67 \text{ lb}$$

From the freebody of the entire system

$$U_{net} = (W_A \sin\theta_A - F_A) \cdot S_A - (W_B \sin\theta_B + F_B) \cdot S_B$$
$$= (200 \sin 30^\circ - 43.3) S_A - (100 \sin 60^\circ + 16.67) \cdot \frac{S_A}{2} \quad \left[\text{Substituting } S_B = \frac{S_A}{2}\right]$$
$$= 56.7 S_A - 51.64 S_A$$
$$= 5.06 S_A$$

$$\Delta KE = \frac{1}{2}\frac{W_A}{g} v_A^2 + \frac{1}{2} \cdot \frac{W_B}{g} \cdot v_B^2$$
$$= \frac{1}{2} \cdot \frac{200}{32.2} v_A^2 + \frac{1}{2} \cdot \frac{100}{32.2} \frac{v_A^2}{4} \quad \left[\because v_B = \frac{v_A}{2}\right]$$
$$= 3.49 v_A^2$$
$$= 3.49 \times 2 a_A S_A \quad \left[\because v_A^2 = 2 a_A S_A\right]$$
$$= 6.98 a_A S_A$$

contd....

#1138/P.328 Contd...
Using Energy Principle

Now $U_{net} = \Delta KE$

$\Rightarrow 5.06 S_A = 6.98 a_A S_A$

$\therefore a_A = 0.725 \text{ fps}^2$, Since a_A is +ve, our assumed direction of motion is correct.

$S_A = \frac{1}{2} a_A t^2 = \frac{1}{2} \times 0.725 \times 30^2 = \boxed{326.25 \text{ ft}}$ Ans.

From the freebody of A, $\Sigma F_x = m_A a_A$

$\Rightarrow W_A \sin\theta_A - T - F_A = \frac{W_A}{g} . a_A$

$\Rightarrow 200 \sin 30^\circ - T - 43.3 = \frac{200}{32.2} \times 0.725$

$\therefore T = 52.2 \text{ lb}$

ie $T_C = \boxed{52.2 \text{ lb}}$ Ans.

$T_D = 2T_C = 2 \times 52.2 = \boxed{104.4 \text{ lb}}$ Ans