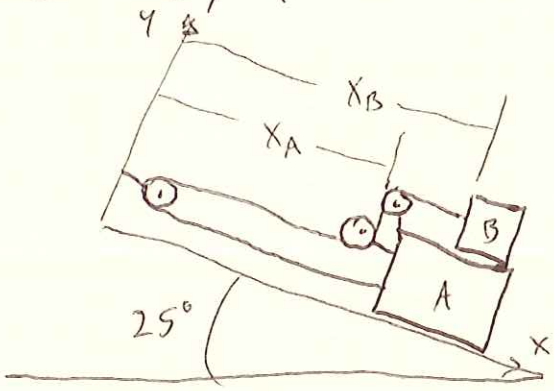
PROB. 12-15

$m_A = 40\ kg$, $m_B = 8\ kg$, $\mu_s = 0.20$, $\mu_k = 0.15$, $\beta = 0$

FIND $a_B$, $T$




$2x_A + (x_B - x_A) = \text{CONST.}$

$x_A + x_B = \text{CONST.}$

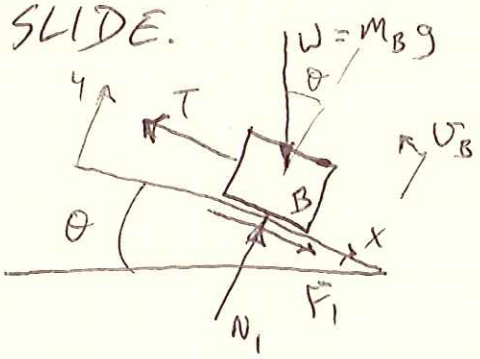
$v_A + v_B = 0$

$a_A + a_B = 0$

$\boxed{a_B = -a_A}$

IMPENDING MOTION: FIND $\theta$ WHEN BLOCKS BEGIN TO SLIDE.

BLOCK B:




$\Sigma F_x = 0$: $m_B g \sin\theta + \mu_s N_1 - T = 0$

$T = m_B g \sin\theta + \mu_s N_1$

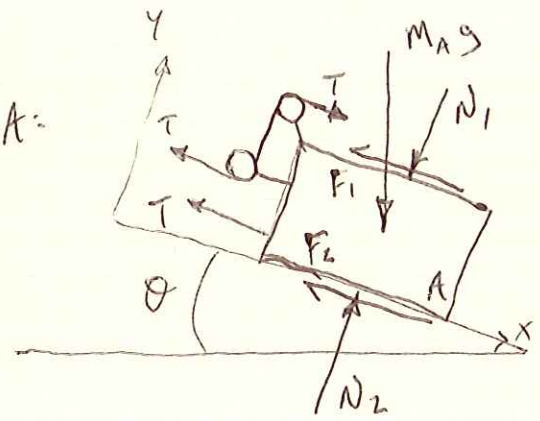
$\Sigma F_y = 0$: $-m_B g \cos\theta + N_1 = 0 \Rightarrow N_1 = m_B g \cos\theta$

$\boxed{T = m_B g \sin\theta + \mu_s m_B g \cos\theta}$

BLOCK A:

PROB. 12-15 CONT.

BLOCK A:




$F_1 = \mu_s N_1, \quad F_2 = \mu_s N_2$

$\nearrow v_A \quad \Sigma F_x = 0:$

$$M_A g \sin\theta - \mu_s N_1 - \mu_s N_2 - T = 0$$

$$T = M_A g \sin\theta - \mu_s N_1 - \mu_s N_2$$

$$\Sigma F_y = 0: \quad N_2 - N_1 - M_A g \cos\theta = 0$$

$$N_2 = N_1 + M_A g \cos\theta = M_B g \cos\theta + M_A g \cos\theta$$

$$T = M_A g \sin\theta - \mu_s \cdot M_B g \cos\theta - \mu_s \cdot (M_B g \cos\theta + M_A g \cos\theta)$$

$$\boxed{T = M_A g \sin\theta - 2\mu_s M_B g \cos\theta - \mu_s M_A g \cos\theta}$$

SET $T = T$:

$$M_B g \sin\theta + \mu_s M_B g \cos\theta = M_A g \sin\theta - 2\mu_s M_B g \cos\theta - \mu_s M_A g \cos\theta$$

$$(M_B - M_A)\sin\theta = -\mu_s (M_B + 2M_B + M_A)\cos\theta$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{\mu_s (3M_B + M_A)}{(M_A - M_B)}$$

$$\theta = \tan^{-1}\left[\frac{\mu_s (3M_B + M_A)}{(M_A - M_B)}\right]$$

PROB. 12-15 CONT.

$$\theta = \tan^{-1}\left\{\frac{(0.2)[3(8)+(40)]}{[(40)-(8)]}\right\} = 21.80^\circ$$

SINCE BLOCKS ARE AT 25°, THE BLOCKS WILL MOVE.

BLOCK B: $\Sigma F_x = m a_x$

$$m_B g \sin 25^\circ + \mu_K N_1 - T = m_B a_B$$

$$\Sigma F_y = m a_y : -m_B g \cos 25^\circ + N_1 = 0 \Rightarrow N_1 = m_B g \cos 25^\circ$$

$$\boxed{T = m_B g \sin 25^\circ + \mu_K m_B g \cos 25^\circ - m_B a_B}$$

BLOCK A: $\Sigma F_x = m a_x$

$$m_A g \sin 25^\circ - \mu_K N_1 - \mu_K N_2 - T = m_A a_A$$

$$\Sigma F_y = m a_y : N_2 - N_1 - m_A g \cos 25^\circ = 0$$

$$N_2 = N_1 + m_A g \cos 25^\circ = m_B g \cos 25^\circ + m_A g \cos 25^\circ$$

$$T = m_A g \sin 25^\circ - \mu_K m_B g \cos 25^\circ - \mu_K (m_B g \cos 25^\circ + m_A g \cos 25^\circ) - m_A a_A$$

$$\boxed{T = m_A g \sin 25^\circ - 2\mu_K m_B g \cos 25^\circ - \mu_K m_A g \cos 25^\circ - m_A a_A}$$

SET $T = T$:

PROB. 12-15 CONT.

$$m_B g \sin 25^\circ + \mu_K m_B g \cos 25^\circ - m_B(-a_A) = m_A g \sin 25^\circ - 2\mu_K m_B g \cos 25^\circ - \mu_K m_A g \cos 25^\circ - m_A a_A$$

$$(m_B + m_A) a_A = -m_B g \sin 25^\circ - \mu_K m_B g \cos 25^\circ + m_A g \sin 25^\circ - 2\mu_K m_B g \cos 25^\circ - \mu_K m_A g \cos 25^\circ$$

$$a_A = \frac{g}{(m_B + m_K)} \cdot \left(m_A \sin 25^\circ - 3\mu_K m_B \cos 25^\circ - m_B \sin 25^\circ - \mu_K m_A \cos 25^\circ\right)$$

$$a_A = \frac{\left(9.81 \frac{m}{s^2}\right)}{(9 + 40^{kg})} \cdot \left[(40^{kg}) \sin 25^\circ - 3(0.15)(8^{kg}) \cos 25^\circ - (8^{kg}) \sin 25^\circ - (0.15)(40^{kg}) \cos 25^\circ\right]$$

$$a_A = 0.9857 \frac{m}{s^2}$$

$$a_B = -a_A = -0.9857 \frac{m}{s^2}$$

$$T = m_B g \sin 25^\circ + \mu_K m_B g \cos 25^\circ - m_B a_B$$

$$T = m_B \left[g(\sin 25^\circ + \mu_K \cos 25^\circ) - a_B\right]$$

$$T = (8^{kg})\left\{\left(9.81 \frac{m}{s^2}\right)\left[\sin 25^\circ + (0.15)\cos 25^\circ\right] - \left(-0.9857 \frac{m}{s^2}\right)\right\}$$

$$T = 51.72^{N}$$