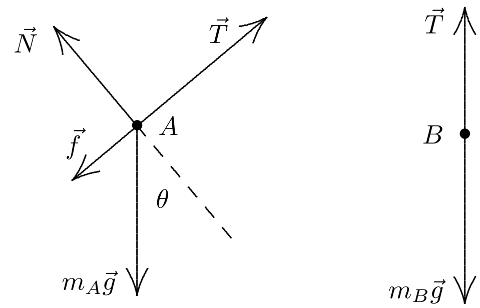
21. First, we check to see if the bodies start to move. We assume they remain at rest and compute the force of (static) friction which holds them there, and compare its magnitude with the maximum value $\mu_s N$. The free-body diagrams are shown below. T is the magnitude of the tension force of the string, f is the magnitude of the force of friction on body A, N is the magnitude of the normal force of the plane on body A, $m_A\vec{g}$ is the force of gravity on body A (with magnitude $W_A = 102$ N), and $m_B\vec{g}$ is the force of gravity on body B (with magnitude $W_B = 32$ N). $\theta = 40°$ is the angle of incline. We are not told the direction of $\vec{f}$ but we assume it is downhill. If we obtain a negative result for f, then we know the force is actually up the plane.



(a) For A we take the $+x$ to be uphill and $+y$ to be in the direction of the normal force. The x and y components of Newton's second law become

$$\begin{aligned} T - f - W_A \sin\theta &= 0 \\ N - W_A \cos\theta &= 0 \,. \end{aligned}$$

Taking the positive direction to be *downward* for body B, Newton's second law leads to

$$W_B - T = 0 \,.$$

Solving these three equations leads to

$$f = W_B - W_A \sin\theta = 32 - 102 \sin 40° = -34 \text{ N}$$

(indicating that the force of friction is *uphill*) and to

$$N = W_A \cos\theta = 102 \cos 40° = 78 \text{ N}$$

which means that $f_{s,\max} = \mu_s N = (0.56)(78) = 44$ N. Since the magnitude f of the force of friction that holds the bodies motionless is less than $f_{s,\max}$ the bodies remain at rest. The acceleration is zero.

(b) Since A is moving up the incline, the force of friction is downhill with magnitude $f_k = \mu_k N$. Newton's second law, using the same coordinates as in part (a), leads to

$$\begin{aligned} T - f_k - W_A \sin\theta &= m_A\, a \\ N - W_A \cos\theta &= 0 \\ W_B - T &= m_B\, a \end{aligned}$$

for the two bodies. We solve for the acceleration:

$$\begin{aligned} a &= \frac{W_B - W_A \sin\theta - \mu_k W_A \cos\theta}{m_B + m_A} \\ &= \frac{32\,\text{N} - (102\,\text{N}) \sin 40° - (0.25)(102\,\text{N}) \cos 40°}{(32\,\text{N} + 102\,\text{N}) \,/\, \left(9.8\,\text{m/s}^2\right)} \\ &= -3.9 \text{ m/s}^2 \,. \end{aligned}$$