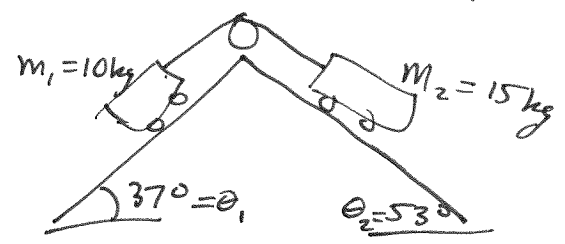


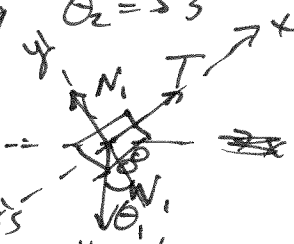
Chapter 6

Problem 44

$m_1 = 10 \text{ kg}$ $\theta_1 = 37^\circ$
 $m_2 = 15 \text{ kg}$ $\theta_2 = 53^\circ$



For Cart #1



line up the x-axis with the up slope direction

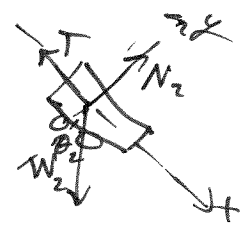
$\sum \vec{F} = m\vec{a}$
 $\vec{N}_1 + \vec{W}_1 + \vec{T} = m\vec{a}$

$N_1 \hat{j} - m_1 g \sin \theta_1 \hat{i} - m_1 g \cos \theta_1 \hat{j} + T \hat{i} = m_1 a \hat{i}$

x-dir) $-m_1 g \sin \theta_1 + T = m_1 a$ (#1)

y-dir) $N - m_1 g \cos \theta_1 = 0$ (#2)

For Cart #2



line up the x-axis with the downslope direction. This is consistent with the first cart. If cart #1 goes up the hill (+x), then cart #2 will go down its slope (+x)

$\sum \vec{F} = m\vec{a}$
 $\vec{N}_2 + \vec{W}_2 + \vec{T} = m\vec{a}$

$N_2 \hat{j} + m_2 g \sin \theta_2 \hat{i} - m_2 g \cos \theta_2 \hat{j} - T \hat{i} = m_2 a \hat{i}$

x-dir) $m_2 g \sin \theta_2 - T = m_2 a$ (#3)

y-dir) $N - m_2 g \cos \theta_2 = 0$ (#4)

Take (#3) and sub into (#1) to eliminate 'ma'

~~$m_2 g \sin \theta_2 - T = m_1 a = -m_1 g \sin \theta_1 + T$
 $m_2 g \sin \theta_2 + m_1 g \sin \theta_1 = 2T$~~

Take #3 and solve for 'a':

$$a = \frac{m_2 g \sin \theta_2 - T}{m_2} = g \sin \theta_2 - \frac{T}{m_2} \quad \text{\#5}$$

Sub into #1

$$\frac{-m_1 g \sin \theta_1 + T}{m_1} = \frac{m_1 \left(g \sin \theta_2 - \frac{T}{m_2} \right)}{m_1}$$

$$-g \sin \theta_1 + \frac{T}{m_1} = g \sin \theta_2 - \frac{T}{m_2}$$

$$\frac{T}{m_1} + \frac{T}{m_2} = g \sin \theta_2 + g \sin \theta_1$$

$$\frac{m_2 T + m_1 T}{m_1 m_2} = g [\sin \theta_2 + \sin \theta_1]$$

$$T(m_1 + m_2) = m_1 m_2 g [\sin \theta_1 + \sin \theta_2]$$

$$T = \frac{m_1 m_2 g [\sin \theta_1 + \sin \theta_2]}{m_1 + m_2}$$

$$\begin{aligned} T &= \frac{(10 \text{ kg})(15 \text{ kg})(9.80 \text{ m/s}^2) [\sin(37^\circ) + \sin(53^\circ)]}{10 \text{ kg} + 15 \text{ kg}} \\ &= 58.8 \text{ N}(1.40) = \boxed{82.3 \text{ N}} \end{aligned}$$

Substitute into #5

$$a = g \sin \theta_2 - \frac{T}{m_2} = (9.80 \text{ m/s}^2) \sin(53^\circ) - \frac{82.3 \text{ N}}{15 \text{ kg}}$$

$$a = 7.827 - 5.487 = \boxed{2.34 \text{ m/s}^2}$$

Since a is positive, it means

the cart #1 (10 kg) moves up the ramp
and cart #2 (15 kg) moves down the ramp.