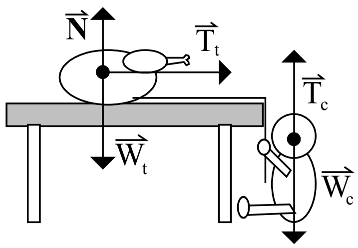
Chapter 5 Problem 20 [†]



Given
$m_c = 12\ kg$
$m_t = 6.8\ kg$
$\Delta x = 60\ cm = 0.60\ m$

Solution
a) Find the acceleration of the turkey.

Newton's 2^{nd} law applied to the turkey is

$$\Sigma \vec{F} = m\vec{a}$$

$$\vec{N} + \vec{T}_t + \vec{W}_t = m_t\vec{a}$$

Choose the coordinate system with the x coordinate begin horizontal. The acceleration of the turkey is in the $+x$ direction.

$$N\hat{j} + T\hat{i} - m_t g\hat{j} = m_t a\hat{i}$$

The x-component of this equation is

$$T = m_t a$$

The y-component of this equation is

$$N - m_t g = 0$$

Newton's 2^{nd} law applied to the child is

$$\Sigma \vec{F} = m\vec{a}$$

$$\vec{T}_c + \vec{W}_c = m_c\vec{a}$$

Choose the coordinate system with the x coordinate being horizontal. The acceleration of the child is in the $-y$ direction.

$$T\hat{j} - m_c g\hat{j} = -m_c a\hat{j}$$

The y-component of this equation is

$$T - m_c g = -m_c a$$

[†]Problem from Essential University Physics, Wolfson

Take the x-component equation for the turkey and substitute it into the y-component equation for the child and solve for acceleration.

$$m_t a - m_c g = -m_c a$$

$$m_t a + m_c a = m_c g$$

$$a = \frac{m_c g}{m_t + m_c} = \frac{(12\ kg)(9.8\ m/s^2)}{6.8\ kg + 12\ kg} = 6.25\ m/s^2$$

b) Find the time for the turkey to go over the edge.

Begin with the following kinematic equation.

$$r = r_0 + v_0 t + \tfrac{1}{2} a t^2$$

Displacement is $r - r_0$ and the initial velocity is 0, so

$$r - r_0 = \tfrac{1}{2} a t^2$$

Solving for t gives

$$\frac{2(r - r_0)}{a} = t^2$$

$$t = \sqrt{\frac{2(r - r_0)}{a}} = \sqrt{\frac{2(0.60\ m)}{6.25\ m/s^2}}$$

$$t = 0.438\ s$$