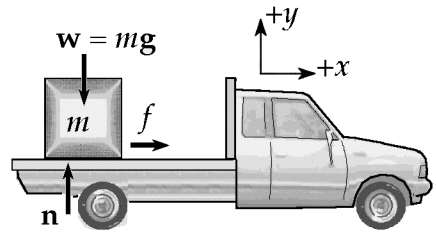
59. A box rests on the back of a truck. The coefficient of static friction between box and truck bed is 0.300. (a) When the truck accelerates forward, what force accelerates the box? (b) Find the maximum acceleration the truck can have before the box slides.

Solution

(a) Due to inertia, the box of mass m will tend to maintain its previous velocity (relative to the Earth) when the truck begins accelerating forward. Thus, the box will tend to slide toward the rear of the truck. The friction force exerted on the box by the truck bed will therefore be directed in the forward direction as it attempts to prevent this slippage.



As seen in the free-body diagram of the box given in the sketch, this friction force f is the resultant horizontal force that will accelerate the box. ◊

(b) The box will have zero acceleration in the vertical (y) direction. Thus,

$$\sum F_y = n - w = 0 \qquad \text{gives} \qquad n = w = mg$$

Therefore, the maximum magnitude a static friction force between the box and truck bed can have is $f_{\max} = \mu_s n = (0.300)mg$. If the box has not started to slip, its horizontal acceleration a_x is the same as the acceleration, a, of the truck. Newton's second law,

$$\sum F_x = m a_x \qquad \text{then gives} \qquad f = ma$$

$$\text{or} \qquad a = \frac{f}{m}$$

To find the maximum acceleration of the truck before slippage will occur, use the maximum static friction force, $f_{\max}$, to obtain:

$$a_{\max} = \frac{f_{\max}}{m} = \frac{(0.300)mg}{m} = (0.300)\left(9.80 \text{ m/s}^2\right) = 2.94 \text{ m/s}^2 \qquad \text{◊}$$