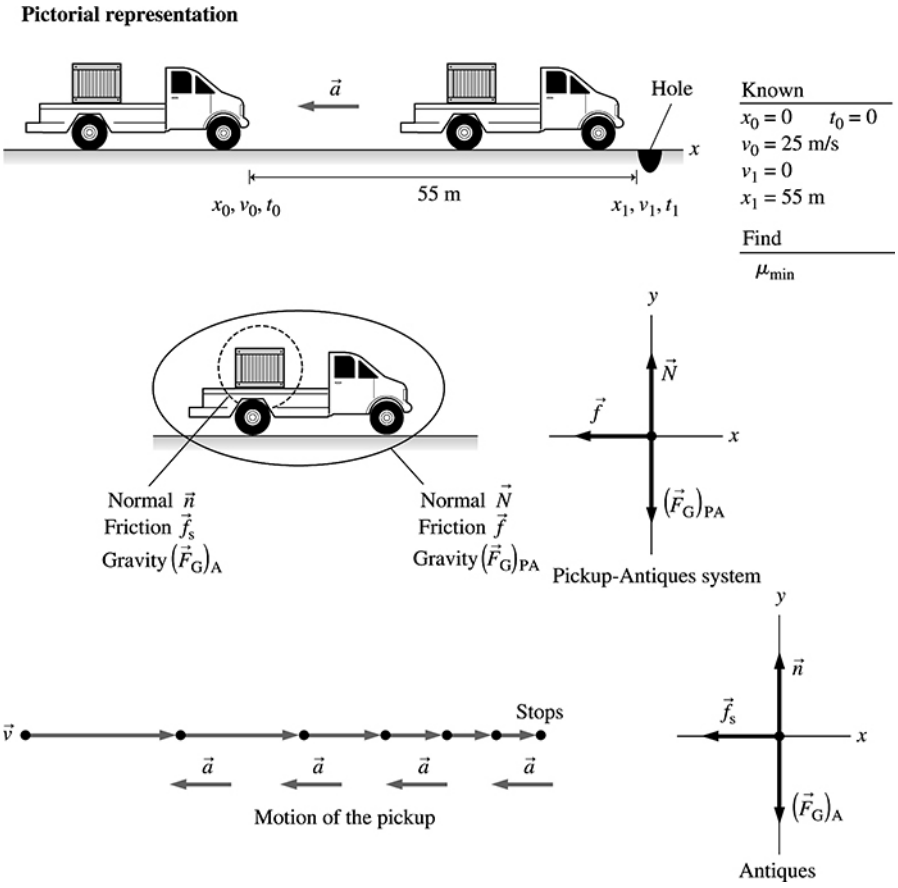
6.50. Model: The antiques (mass = m) in the back of your pickup (mass = M) will be treated as a particle. The antiques touch the truck's steel bed, so only the steel bed can exert contact forces on the antiques. The pickup-antiques system will also be treated as a particle, and the contact force on this particle will be due to the road.

Visualize:



Solve: **(a)** We will find the smallest coefficient of friction that allows the truck to stop in 55 m, then compare that to the known coefficients for rubber on concrete. For the pickup-antiques system, with mass $m+M$, Newton's second law is

$$(F_{net})_x = \Sigma F_x = N_x + \left((F_G)_{PA}\right)_x + (f)_x = 0\text{ N} + 0\text{ N} - f = (m+M)a_x = (m+M)a$$

$$(F_{net})_y = \Sigma F_y = N_y + \left((F_G)_{PA}\right)_y + (f)_y = \text{N} - (m+M)g + 0\text{ N} = 0\text{ N}$$

The model of static friction is $f = \mu N$, where μ is the coefficient of friction between the tires and the road. These equations can be combined to yield $a = -\mu g$. Since constant-acceleration kinematics gives $v_1^2 = v_0^2 + 2a(x_1 + x_0)$, we find

$$a = \frac{v_1^2 - v_0^2}{2(x_1 - x_0)} \Rightarrow \mu_{min} = \frac{v_0^2}{2g(x_1 - x_0)} = \frac{(25\text{ m/s})^2}{(2)(9.8\text{ m/s}^2)(55\text{ m})} = 0.58$$

The truck cannot stop if μ is smaller than this. But both the static and kinetic coefficients of friction, 1.00 and 0.80 respectively (see Table 6.1), are larger. So the truck can stop.

(b) The analysis of the pickup-antiques system applies to the antiques, and it gives the same value of 0.58 for μ_{min}. This value is smaller than the given coefficient of static friction ($\mu_s = 0.60$) between the antiques and the truck bed. Therefore, the antiques will not slide as the truck is stopped over a distance of 55 m.

Assess: The analysis of parts (a) and (b) are the same because mass cancels out of the calculations. According to the California Highway Patrol Web site, the stopping distance (with zero reaction time) for a passenger vehicle traveling at 25 m/s or 82 ft/s is approximately 43 m. This is smaller than the 55 m over which you are asked to stop the truck.