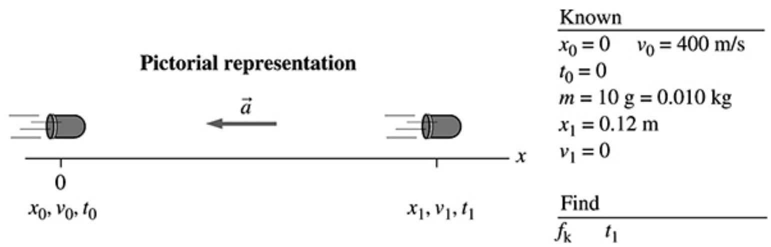
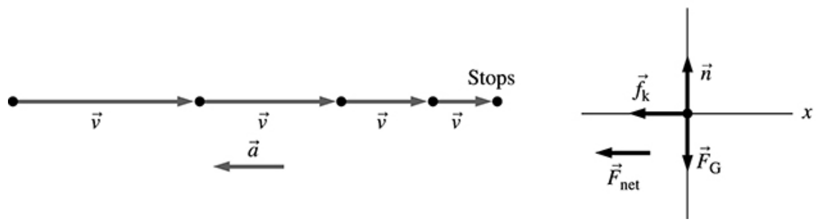
6.38. Model: We will represent the bullet as a particle.
Visualize:





Solve: **(a)** We have enough information to use kinematics to find the acceleration of the bullet as it stops. Then we can relate the acceleration to the force with Newton's second law. (Note that the barrel length is not relevant to the problem.) The kinematic equation is

$$v_1^2 = v_0^2 + 2a\Delta x \Rightarrow a = -\frac{v_0^2}{2\Delta x} = -\frac{(400\text{ m/s})^2}{2(0.12\text{ m})} = -6.67\times10^5\text{ m/s}^2$$

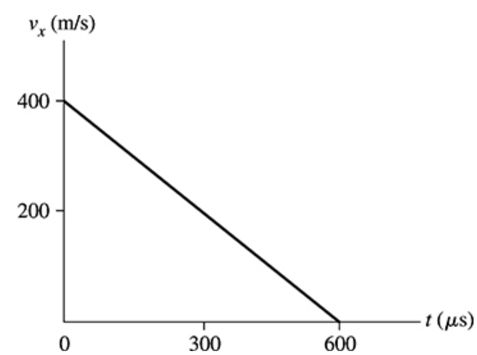
Notice that a is negative, in agreement with the vector $\vec{a}$ in the motion diagram. Turning to forces, the wood exerts two forces on the bullet. First, an upward normal force that keeps the bullet from "falling" through the wood. Second, a retarding frictional force $\vec{f}_k$ that stops the bullet. The only horizontal force is $\vec{f}_k$, which points to the left and thus has a negative x-component. The x-component of Newton's second law is

$$(F_{net})_x = -f_k = ma \Rightarrow f_k = -ma = -(0.01\text{ kg})(-6.67\times10^5\text{ m/s}^2) = 6670\text{ N}$$

Notice how the signs worked together to give a positive value of the magnitude of the force.
(b) The time to stop is found from $v_1 = v_0 + a\Delta t$ as follows:

$$\Delta t = -\frac{v_0}{a} = 6.00\times10^{-4}\text{ s } = 600\ \mu\text{s}$$

(c)



Using the above kinematic equation, we can find the velocity as a function of t. For example at $t = 60\ \mu$s,

$$v_x = 400\text{ m/s} + (-6.667\times10^5\text{ m/s}^2)(60\times10^{-6}\text{ s}) = 360\text{ m/s}$$