59. (a) We choose $+x$ to be away from the armor (pointing back towards the gun). The velocity is there negative-valued and the acceleration is positive-valued. Using Eq. 2-11,

$$0 = \vec{v}_0 + \vec{a}t \implies \vec{a} = -\frac{\vec{v}_0}{t} = -\frac{-300}{40 \times 10^{-6}} = 7.5 \times 10^6 \text{ m/s}^2 .$$

(b) Since the final momentum is zero, the momentum change is

$$\Delta\vec{p} = 0 - m\vec{v}_0 = -(0.0102\,\text{kg})(-300\,\text{m/s}) = 3.1 \text{ kg}\cdot\text{m/s} .$$

(c) We compute $K_f - K_i = 0 - \frac{1}{2}mv_0^2$ and obtain $-\frac{1}{2}(0.0102)(300)^2 \approx -460$ J.

(d) If we assume uniform deceleration, Eq. 2-17 gives

$$\Delta x = \frac{1}{2}\left(\vec{v}_0 + 0\right)t = \frac{1}{2}(-300)\left(40 \times 10^{-6}\right)$$

so that the distance is $|\Delta x| = 0.0060$ m.

(e) By the impulse-momentum theorem, the impulse of the armor on the bullet is $\vec{J} = \Delta\vec{p} = 3.1$ N·s. By Newton's third law, the impulse of the bullet on the armor must have that same magnitude.

(f) Using Eq. 10-8, we find the magnitude of the (average) force exerted by the bullet on the armor:

$$F_{\text{avg}} = \frac{J}{t} = \frac{3.1}{40 \times 10^{-6}} = 7.7 \times 10^4\,\text{N} .$$

(g) From Newton's second law, we find $a_p = F_{\text{avg}}/M$ (where $M = 65$ kg) to be 1.2×10^3 m/s^2.

(h) Momentum conservation leads to $V = mv_0/M = 0.047$ m/s. (This result can be gotten a number of ways, given the information available at this point in the problem.)

(i) Shortening the distance means decreasing the stopping time (Eq. 2-17 shows this clearly) which (recalling our calculation in part (a)) means the magnitude of the bullet's deceleration increases. It does not change the answer to part (b) (for the change in momentum), nor does it affect part (c) (the change in kinetic energy). Since $\vec{J}$ is determined by $\Delta\vec{p}$, part (e) is unchanged. But with t smaller, $J/t = F_{\text{avg}}$ is larger, as is a_p. Finally, v_p is the same as before since momentum conservation describes the input/output of the collision and not the inner dynamics of it.