extra credit Ch 7-54

$D = 25.4\ mm$

steel - density ~ iron $= 7.9 \times 10^3\ kg/m^3$

a) interaction acts for nonzero Δt (acceleration $\neq$ infinite)

b) spring constant $k = F/\Delta x = \frac{16000\ N}{0.2 \times 10^{-3}\ m} = 8.0 \times 10^7\ N/m$

c) $KE = \frac{1}{2} m v^2$ $\quad m = \rho V = (7.9 \times 10^3\ kg/m^3)\left(\frac{4}{3}\pi\right)\left(\frac{25.4 \times 10^{-3}\ m}{2}\right)^3 = 0.068\ kg$

so KE of one $= \frac{1}{2}(0.068\ kg)(5\ m/s)^2 = 0.85\ J = K_i$

d) each ball is like a spring with $k \approx 8.0 \times 10^7\ N/m$, and compresses from $x_i = 0$ to x_f, OO → OD

so to stop, work done by other ball $= \Delta KE$ when $v = 0$

$$\frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2 = K_f - K_i$$

$$0 - \frac{1}{2}kx_f^2 = 0 - K_i$$

$$\Rightarrow x_f = \sqrt{\frac{2K_i}{k}} = \sqrt{\frac{2(0.85\ J)}{8 \times 10^7\ N/m}} = 1.5 \times 10^{-4}\ m$$

$$= 0.15\ mm$$

e) ball goes from 5 m/s to 0 m/s in $\Delta x = 0.15\ mm$

if $a = const \Rightarrow \quad v_f^2 = v_i^2 + 2a\Delta x$

$$0 = (5\ m/s)^2 + 2a(1.5 \times 10^{-4}\ m) \rightarrow a = -8.3 \times 10^4\ m/s^2$$

so $a = \frac{\Delta v}{\Delta t} \rightarrow \Delta t \sim \frac{\Delta v}{a} = \frac{0 - 5\ m/s}{-8.3 \times 10^4\ m/s^2} = 6 \times 10^{-5}\ s$

$$\sim 10^{-4}\ s$$