Problem 2.17

(a) Air initially at 20°C is compressed by a factor of 15. Assuming adiabatic conditions, $V_i/15 = V_f$, $T_i = 293\text{K}$, and $\gamma = 1.4$,

$$TV^{\gamma-1} = C \tag{1}$$

$$\begin{aligned} T_i V_i^{\gamma-1} &= T_f V_f^{\gamma-1} \\ 293 V_i^{0.4} &= T_f \left(\frac{V_i}{15}\right)^{0.4} \\ 293 &= T_f \left(\frac{1}{15}\right)^{0.4} \\ T_f &= 293 \left(\frac{1}{15}\right)^{-0.4} \end{aligned}$$

$$\boxed{T_f = 866\text{ K}} \tag{2}$$

Assuming air behaves like an ideal gas,

$$\frac{P_i V_i}{T_i} = \frac{P_f V_f}{T_f} \tag{3}$$

$$\begin{aligned} \frac{P_i V_f}{(293)(15)} &= \frac{P_f V_f}{866} \\ \frac{P_i}{(293)(15)} &= \frac{P_f}{866} \end{aligned}$$

$$\boxed{P_i \approx 5P_f} \tag{4}$$

(b) If the compression is isothermal,

$$P_i V_i = P_f V_f \tag{5}$$

$$\boxed{P_i = 15P_f} \tag{6}$$

(c) The pressure increases more with non-isothermal compression.