19.13 This problem asks that we calculate the values of c_v for aluminum and iron at room temperature using Equation 19.10, the data in Table 19.1, given that $\alpha_v = 3\alpha_l$, and also values of the compressibility. From Equation 19.10

$$c_v = c_p - \frac{\alpha_v^2 v_0 T}{\beta}$$

And, from Table 19.1 and the problem statement

$c_p(\text{Al}) = 900$ J/kg-K
$c_p(\text{Fe}) = 448$ J/kg-K
$\alpha_v(\text{Al}) = (3)[23.6 \times 10^{-6}\ (°\text{C})^{-1}] = 7.08 \times 10^{-5}\ (°\text{C})^{-1}$
$\alpha_v(\text{Fe}) = (3)[(11.8 \times 10^{-6}\ (°\text{C})^{-1}] = 3.54 \times 10^{-5}\ (°\text{C})^{-1}$
$\beta(\text{Al}) = 1.77 \times 10^{-11}\ (\text{Pa})^{-1}$
$\beta(\text{Fe}) = 2.65 \times 10^{-12}\ (\text{Pa})^{-1}$

The specific volume is just the reciprocal of the density; thus, in units of m^3/kg

$$v_0(\text{Al}) = \frac{1}{\rho} = \left(\frac{1}{2.71\ \text{g/cm}^3}\right)\left(\frac{1000\ \text{g}}{\text{kg}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)^3 = 3.69 \times 10^{-4}\ \text{m}^3/\text{kg}$$

$$v_0(\text{Fe}) = \left(\frac{1}{7.87\ \text{g/cm}^3}\right)\left(\frac{1000\ \text{g}}{\text{kg}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)^3 = 1.27 \times 10^{-4}\ \text{m}^3/\text{kg}$$

Therefore, for aluminum

$$c_v(\text{Al}) = c_p(\text{Al}) - \frac{\alpha_v^2(\text{Al})\ v_0(\text{Al})T}{\beta(\text{Al})}$$

$$= 900\ \text{J/kg-K} - \frac{\left[7.08 \times 10^{-5}\ (°\text{C})^{-1}\right]^2 (3.69 \times 10^{-4}\ \text{m}^3/\text{kg})(293\ \text{K})}{1.77 \times 10^{-11}\ (\text{N/m}^2)^{-1}}$$

$$= 869\ \text{J/kg-K}$$

And, also for iron