19.11 In this problem we are asked to determine the density of iron at 700°C. Let us use as the basis for this determination 1 cm^3 of material at 20°C, which has a mass of 7.870 g; it is assumed that this mass will remain constant upon heating to 700°C. Let us compute the volume expansion of this cubic centimeter of iron as it is heated to 700°C. A volume expansion expression is given in Equation 19.4—viz.,

$$\frac{\Delta V}{V_0} = \alpha_v \Delta T$$

or

$$\Delta V = V_0 \alpha_v \Delta T$$

Also, $\alpha_v = 3\alpha_l$, as stipulated in the problem. The value of α_l given in Table 19.1 for iron is 11.8 x 10^{-6} $(°C)^{-1}$. Therefore, the volume, V, of this specimen of Fe at 700°C is just

$$V = V_0 + \Delta V = V_0(1 + \alpha_v \Delta T) = V_0(1 + 3\alpha_l \Delta T)$$

$$= (1\ cm^3)\left\{1 + (3)\left[11.8\ \text{x}\ 10^{-6}\ (°C)^{-1}\right](700°C - 20°C)\right\}$$

$$= 1.02471\ cm^3$$

Thus, the density is just the 7.870 g divided by this new volume—i.e.,

$$\rho = \frac{7.870\ g}{1.02471\ cm^3} = 7.680\ g/cm^3$$