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<sup>3</sup> 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  $\alpha_l$  given in Table 19.1 for iron is 11.8 x 10<sup>-6</sup> (°C)<sup>-1</sup>. Therefore, the volume, *V*, of this specimen of Fe at 700°C is just

$$V = V_0 + \Delta V = V_0 (1 + \alpha_v \Delta T) = V_0 (1 + 3\alpha_l \Delta T)$$
$$= (1 \text{ cm}^3) \{ 1 + (3) [11.8 \text{ x} 10^{-6} (^{\circ}\text{C})^{-1}] (700^{\circ}\text{C} - 20^{\circ}\text{C}) \}$$
$$= 1.02471 \text{ cm}^3$$

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

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

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