Atkins 3.9 (2)

Calculate the work done in compressing a substance from $L = L_0$ to $L = \frac{1}{2} L_0$ if the eqn. of state is

$$f = bT\left(\frac{L}{L_0} - \frac{L_0^2}{L^2}\right)$$

$$W = \int_{L_0}^{\frac{1}{2}L_0} bT\left(\frac{L}{L_0} - \frac{L_0^2}{L^2}\right) dL$$

$$= bT\left(\frac{L^2}{2L_0} + \frac{L_0^2}{L}\right)_{L_0}^{\frac{1}{2}L_0}$$

$$= bT\left(\frac{L_0^2}{8L_0} + \frac{2L_0^2}{L_0} - \frac{L_0^2}{2L_0} - \frac{L_0^2}{L_0}\right)$$

$$= bT\left(L_0\right)\left(\frac{1}{8} + 2 - \frac{1}{2} - 1\right)$$

$$= bTL_0\left(\frac{1}{8} + \frac{16}{8} - \frac{4}{8} - \frac{8}{8}\right)$$

$$\boxed{W = \frac{5bTL_0}{8}}$$