63. (a) We use $p_i V_i^\gamma = p_f V_f^\gamma$ to compute γ:

$$\gamma = \frac{\log(p_i/p_f)}{\log(V_f/V_i)} = \frac{\log(1.0\,\text{atm}/1.0\times 10^5\,\text{atm})}{\log(1.0\times 10^3\,\text{L}/1.0\times 10^6\,\text{L})} = \frac{5}{3}\ .$$

Therefore the gas is monatomic.

(b) Using the gas law in ratio form (see Sample Problem 20-1), the final temperature is

$$T_f = T_i \frac{p_f V_f}{p_i V_i} = (273\,\text{K}) \frac{(1.0\times 10^5\,\text{atm})(1.0\times 10^3\,\text{L})}{(1.0\,\text{atm})(1.0\times 10^6\,\text{L})} = 2.7\times 10^4\ \text{K}\ .$$

(c) The number of moles of gas present is

$$n = \frac{p_i V_i}{RT_i} = \frac{(1.01\times 10^5\,\text{Pa})\left(1.0\times 10^3\,\text{cm}^3\right)}{\left(8.31\,\frac{\text{J}}{\text{mol·K}}\right)(273\,\text{K})} = 4.5\times 10^4\ \text{mol}\ .$$

(d) The total translational energy per mole before the compression is

$$K_i = \frac{3}{2}RT_i = \frac{3}{2}\left(8.31\,\frac{\text{J}}{\text{mol}\cdot\text{K}}\right)(273\,\text{K}) = 3.4\times 10^3\ \text{J}\ .$$

After the compression,

$$K_f = \frac{3}{2}RT_f = \frac{3}{2}\left(8.31\,\frac{\text{J}}{\text{mol}\cdot\text{K}}\right)\left(2.7\times 10^4\,\text{K}\right) = 3.4\times 10^5\ \text{J}\ .$$

(e) Since $v_{\text{rms}}^2 \propto T$, we have

$$\frac{v_{\text{rms},i}^2}{v_{\text{rms},f}^2} = \frac{T_i}{T_f} = \frac{273\,\text{K}}{2.7\times 10^4\,\text{K}} = 0.01\ .$$