18.50. Solve: **(a)** From Equation 18.26 $v_{rms} = \sqrt{3k_B T/m}$. For an adiabatic process

$$T_f V_f^{\gamma-1} = T_i V_i^{\gamma-1} \Rightarrow T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1} \Rightarrow T_f = T_i (8)^{\frac{5}{3}-1} = 4T_i$$

The root-mean-square speed increases by a factor of 2 with an increase in temperature.

(b) From Equation 18.3 $\lambda = \left[4\sqrt{2}\pi(N/V)r^2\right]^{-1}$. A decrease in volume decreases the mean free path by a factor of 1/8.

(c) For an adiabatic process,

$$T_f V_f^{\gamma-1} = T_i V_i^{\gamma-1} \Rightarrow T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1} = T_i (8)^{\frac{5}{3}-1} = 4T_i$$

Because the decrease in volume increases T_f, the thermal energy increases by a factor of 4.

(d) The molar specific heat at constant volume is $C_V = \frac{3}{2}R$, a constant. It does not change.