19. Table 19-1 gives $M$ = 28.0 g/mol for nitrogen. This value can be used in Eq. 19-22 with $T$ in Kelvins to obtain the results. A variation on this approach is to set up ratios, using the fact that Table 19-1 also gives the rms speed for nitrogen gas at 300 K (the value is 517 m/s). Here we illustrate the latter approach, using $v$ for $v_{\text{rms}}$:

$$\frac{v_2}{v_1} = \frac{\sqrt{3RT_2/M}}{\sqrt{3RT_1/M}} = \sqrt{\frac{T_2}{T_1}}.$$

(a) With $T_2$ = (20.0 + 273.15) K ≈ 293 K, we obtain

$$v_2 = (517\,\text{m/s})\sqrt{\frac{293\,\text{K}}{300\,\text{K}}} = 511\,\text{m/s}.$$

(b) In this case, we set $v_3 = \frac{1}{2}v_2$ and solve $v_3/v_2 = \sqrt{T_3/T_2}$ for $T_3$:

$$T_3 = T_2\left(\frac{v_3}{v_2}\right)^2 = (293\,\text{K})\left(\frac{1}{2}\right)^2 = 73.0\,\text{K}$$

which we write as 73.0 – 273 = – 200°C.

(c) Now we have $v_4 = 2v_2$ and obtain

$$T_4 = T_2\left(\frac{v_4}{v_2}\right)^2 = (293\,\text{K})(4) = 1.17\times10^3\,\text{K}$$

which is equivalent to 899°.