222.

Problem 24.27 (RHK)

The root-mean-square (rms) *speed of hydrogen molecules at* 0^0C *is* 1840 m s^{-1}. *We have to compute the speed of colloidal particles of "molar mass"* 3.2×10^6 g mol^{-1}.

Solution:

Relation between the average kinetic energy of a particle of mass *m* in a gas at temperature *T* is

$$\frac{1}{2}mv_{rms}^2=\frac{3}{2}kT,$$

or

$$v_{rms}=\sqrt{\frac{3kT}{m}}.$$

We have to find the V_{rms} of colloidal particles of molar mass

$M=3.2\times10^6$ g mol^{-1}.

Therefore, the mass of a single colloidal particle will be

$$m=\frac{M}{N_A}=\frac{3.2\times10^3}{6.02\times10^{23}}\ \text{kg}=5.32\times10^{-21}\ \text{kg}.$$

And, the rms speed of the colloidal particles will be

$$V_{rms} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 273.16}{5.32 \times 10^{-21}}} \text{ m s}^{-1}$$

$$= 1.458 \text{ m s}^{-1} \text{ ; } 1.5 \text{ m s}^{-1}.$$