

222.

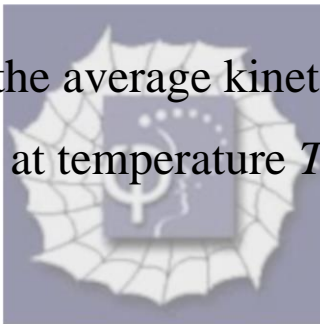
Problem 24.27 (RHK)

The root-mean-square (rms) speed of hydrogen molecules at 0°C is 1840 m s^{-1} . We have to compute the speed of colloidal particles of “molar mass” $3.2 \times 10^6\text{ g mol}^{-1}$.

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

$$M = 3.2 \times 10^6\text{ g mol}^{-1}.$$

Therefore, the mass of a single colloidal particle will be

$$m = \frac{M}{N_A} = \frac{3.2 \times 10^3}{6.02 \times 10^{23}}\text{ kg} = 5.32 \times 10^{-21}\text{ kg}.$$

And, the rms speed of the colloidal particles will be

$$V_{rms} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 273.16}{5.32 \times 10^{-21}}} \text{ m s}^{-1}$$
$$= 1.458 \text{ m s}^{-1} ; 1.5 \text{ m s}^{-1}.$$

