

Answer to the Question#60478-Physics-Molecular Physics and Thermodynamics

Task:

Find difference between the mean square speeds of hydrogen and oxygen molecules at N.T.P.
Take molecular weight of hydrogen and oxygen as 2 and 32.

Solution:

NTP: Temperature $T = 273 \text{ K}$;

Molar masses: $\mu_{H_2} = 0.002 \text{ kg/mol}$; $\mu_{O_2} = 0.032 \text{ kg/mol}$;

Root-Mean-Square speed: $V = \sqrt{\frac{3RT}{\mu}}$

For Hydrogen: $V_{H_2} = \sqrt{\frac{3RT}{\mu_{H_2}}}$; For Oxygen: $V_{O_2} = \sqrt{\frac{3RT}{\mu_{O_2}}}$;

Difference: $V_{H_2} - V_{O_2} = \sqrt{\frac{3RT}{\mu_{H_2}}} - \sqrt{\frac{3RT}{\mu_{O_2}}} = \sqrt{3RT} \left(\frac{1}{\sqrt{\mu_{H_2}}} - \frac{1}{\sqrt{\mu_{O_2}}} \right) = \sqrt{3 * 8.31 * 273} *$

$\left(\frac{1}{\sqrt{0.002}} - \frac{1}{\sqrt{0.0032}} \right) \approx 1384 \text{ m/s} \approx 1.4 \text{ km/s}$

Answer: The difference between RMS speeds of Hydrogen and Oxygen is approximately equal to 1.4 km/s