[TP] The rms speed, u_{rms}, of O_2 at 25 °C is about ("Use units, Luke!") ...

25% 1. 250 m/s
25% 2. 500 m/s
25% 3. 750 m/s
25% 4. 1000 m/s

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Response Counter 10 1

Lecture 7 CH102 A1 (MWF 9:05 am)

Friday, February 3, 2017

- Molecular speeds
- Distribution of molecular speeds

Next: Continue ch11: Real gases: Effect of molecular attraction; Real gases: Effect of molecular size; Real gases: van der Waals equation; phase diagrams

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Calculation of molecular speeds

$u^2_{avg} = 3\ R\ T / M$

is the fundamental connection between microscopic motion and the macroscopic concept temperature and molar mass.

For a given molar mass, higher temperature means ...
faster moving particles.

For a given temperature, higher mass means ...
slower moving particles.

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[TP] The rms speed, u_{rms}, of O_2 at 25 °C is about ("Use units, Luke!") ...

25% 1. 250 m/s
25% 2. 500 m/s
25% 3. 750 m/s
25% 4. 1000 m/s

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Calculate rms speed of O_2 at 25 °C

$u^2_{avg} = 3\ R\ T / M$

$u_{rms} = \sqrt{u^2_{avg}} = \sqrt{3\ R\ T / M}$

$R = 8.314$ J/(K mol), J = kg m^2/s^2

Answer: 482 m/s ≈ 500 m/s

[TP] The rms speed of O_2 at 25 °C is about 500 m/s.

Without using a calculator, use the rms speed of O_2 to estimate that the rms speed of H_2 at the same temperature is about ...

20% 1. 4000 m/s
20% 2. 2000 m/s
20% 3. 1000 m/s
20% 4. 500 m/s
20% 5. 250 m/s

Response Counter 10

Ratio of speed of H_2 to O_2 at 25 °C

Key relation ...

$u_1^2 / u_2^2 = M_2 / M_1$

$u_{H2}^2 / u_{O2}^2 = M_{O2} / M_{H2} = 32/2 = 16$

$u_{H2} = u_{O2} \times 4 = (500\ \text{m/s}) \times 4 = \ldots$

2000 m/s

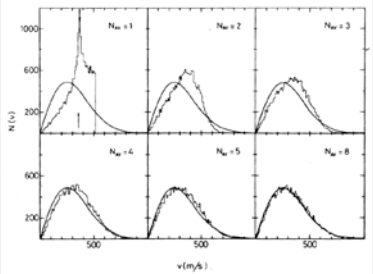
Distribution of molecular speeds

We have said that collisions between gas particles results in the particles having different speeds.

Distribution of molecular speeds

Here is what happens to the speeds of 20,000 particles, all initially at the same speed, after they each have undergone successive numbers of collisions.

Bonomo & Riggi,
Am. J. Phys. ,Vol 52, p 54 (1984)
http://dx.doi.org/10.1119/1.13809



Distribution of molecular speeds

The resulting distribution, known as the Maxwell-Boltzmann distribution, is always the same, depending only on temperature.

u_{rms} versus temperature

The rms speed of H_2 at 300 K is about 2000 m/s.

Sketch the distribution of speeds of H_2 at 300 K

u_{rms} versus temperature

Add to your sketch the distribution of speeds of O_2 at 300 K

u_{rms} versus temperature

Add to your sketch the distribution of speeds of O_2 at 1200 K

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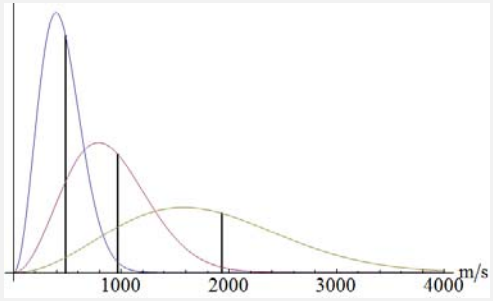
u_{rms} versus temperature

Add to your sketch the distribution of speeds of O_2 at 1200 K



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