CONCEPT: ROOT-MEAN-SQUARE SPEED OF IDEAL GASES

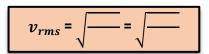
- The **root-mean-square** (RMS) speed of an ideal gas is a type of ______ speed.
 - As the name suggests, it is the square _____ of the ____ of each particle's speed.
 - In general, n_{rms} n_{avg}

EXAMPLE: Using the numbers 5, 11, and 32, calculate:

a) The average (n_{avg})

a) The RMS (nrms)

ullet The RMS **speed** (v_{rms}) of an ideal gas depends *ONLY* on the _____ and the ____ of the gas particles.



THERMO CONSTANTS

 $k_B = 1.38 \times 10^{-23} \frac{J}{K}$

 $R = 8.314 \frac{J}{mol \cdot K}$

- Remember, m = mass [kg] while M = molar mass [kg/mol]
- T MUST be in Kelvin (K)

EXAMPLE: Calculate the rms speed of diatomic hydrogen gas (H_2) at 27°C. For H_2 , the molar mass M = 2 g/mol.

ullet v_{rms} is the "average" speed of particles; many are going above & below that speed.

<u>PROBLEM</u>: What is the temperature of a sample of CO₂ molecules whose rms speed is 300 m/s? The molecular mass for Carbon and Oxygen is 12.01 g/mol and 16 g/mol, respectively.

- **A)** 158.7 K
- **B)** 529.2 K
- **C)** 1.7×10⁵ K
- **D)** 1391 K

IDEAL GAS EQs & Constants $PV = nRT = Nk_BT$ $K_{av} = \frac{3}{2}k_BT$ $E_{int} = \frac{3}{2}nRT$ $v_{rms} = \sqrt{\frac{3k_BT}{m}} = \sqrt{\frac{3RT}{M}}$ $R = 8.314 \frac{J}{mol\ K}$ $k_B = 1.38 \times 10^{-23} \frac{J}{K}$ $N_A = 6.02 \times 10^{23}$

<u>PROBLEM</u>: You fill a 1.6L container filled with 200g of an ideal gas, which has a molecular mass of 28g/mol. If the RMS speed of the gas molecules is 600 m/s, what is the pressure of the gas?

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