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 _______ (average) of the _________ of each particle's speed.
- In general, $n_{rms} \quad n_{avg}$

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

a) The average (n_{avg})

a) The RMS (n_{rms})

● The RMS ***speed*** (v_{rms}) of an ideal gas depends *ONLY* on the _____________ and the _________ of the gas particles.

$$v_{rms} = \sqrt{\frac{\quad}{\quad}} = \sqrt{\frac{\quad}{\quad}}$$

THERMO CONSTANTS
$k_B = 1.38\times10^{-23}\ \frac{J}{K}$
$R = 8.314\ \frac{J}{mol \cdot K}$

- 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.

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

PROBLEM: What is the temperature of a sample of CO_2 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) 1.7×10^5 K
D) 1391 K

IDEAL GAS EQs & Constants
$PV = nRT = Nk_BT$
$K_{av} = \frac{3}{2}k_BT$
$E_{int} = \frac{3}{2}nRT$
$v_{rms} = \sqrt{\frac{3k_BT}{m}} = \sqrt{\frac{3RT}{M}}$
$R = 8.314 \frac{J}{mol\ K}$
$k_B = 1.38\times10^{-23} \frac{J}{K}$
$N_A = 6.02\times10^{23}$

PROBLEM: 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?

IDEAL GAS EQs & Constants
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CONVERSIONS
1L = 0.001 m^3
1 atm = 1.01×10^5 Pa