CONCEPT: INTERNAL ENERGY OF IDEAL MONOATOMIC GASES

- You'll need to know the difference between *Average Kinetic* Energy and *Total Internal* Energy.

  - *AVERAGE* Kinetic Energy *per particle*: $K_{avg} = \frac{3}{2} k_B T$

  - *TOTAL* Internal Energy of *N particles*: $E_{int} = NK_{avg} =$ _____ = _____
    (Sometimes written as U)
    (for single-atom a.k.a _____ gases only)

EXAMPLE: You put 10 particles of an ideal, monoatomic gas at 300K in a container. Calculate the **a)** average kinetic energy; **b)** total internal energy of the gas particles.

EXAMPLE: The total internal energy of a gas at 401K is 2×10^4 J. Calculate the number of moles in this gas.

CONSTANTS

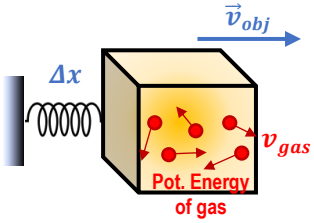
$k_B = 1.38 \times 10^{-23} \frac{J}{K}$

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

- In thermodynamics, we use the ***Internal*** Energy of a gas, which is similar to but different than ***Mechanical*** Energy.

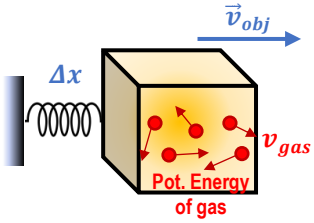
MECHANICAL Energy → _____scopic

- Sum of Kinetic + Potential Energies of the entire object



INTERNAL Energy → _____scopic

- Sum of Kinetic + Potential Energies of the _____ *inside of* objects



PROBLEM: A container filled with 2 mol of an ideal, monoatomic gas is has a total internal energy equal to the kinetic energy of a 0.008kg bullet travelling at 700 m/s. What is the temperature of the gas in Kelvin?

A) 123.2 K
B) 78.6 K
C) 235.7 K
D) 11.2 K

IDEAL GAS EQs & Constants

$PV = nRT = Nk_BT$

$K_{avg} = \frac{3}{2}k_BT$

$E_{int} = \frac{3}{2}nRT$

$R = 8.314 \frac{J}{mol \cdot K} = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

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

$N_A = 6.02 \times 10^{23} \frac{\text{particles}}{\text{mol}}$

PROBLEM: A tank with a volume of 0.300 m^3 is filled with an ideal monoatomic gas. If it contains 10 moles at a pressure of 0.8 atm, what is the total internal energy of the gas in the tank?

IDEAL GAS EQs & Constants

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CONVERSIONS

1L = 0.001 m^3

1 atm = 1.01×10^5 Pa