

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:
(Sometimes written as U)

$$E_{int} = N K_{avg} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

(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

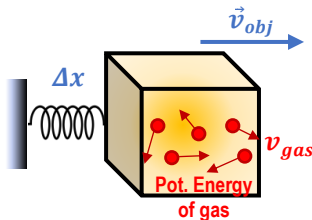
$$k_B = 1.38 \times 10^{-23} \frac{J}{K}$$

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

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

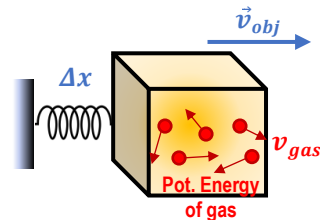
MECHANICAL Energy $\rightarrow$ _____scopic

- Sum of Kinetic + Potential Energies of the entire object



INTERNAL Energy $\rightarrow$ _____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	
$PV = nRT = Nk_B T$ $K_{avg} = \frac{3}{2} k_B T$ $E_{int} = \frac{3}{2} nRT$	
$R = 8.314 \frac{J}{mol \cdot K} = 0.08206 \frac{L \cdot atm}{mol \cdot K}$ $k_B = 1.38 \times 10^{-23} \frac{J}{K}$ $N_A = 6.02 \times 10^{23} \frac{particles}{mol}$	

PROBLEM: A tank with a volume of 0.300 m³ 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?

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CONVERSIONS
1L = 0.001 m ³ 1 atm = 1.01×10 ⁵ Pa