- **1 Mole [mol]** of any substance contains the same number of molecules , called **Avogadro Number:**

$$N_A \approx 6.02 \cdot 10^{23} \frac{1}{mol}$$

- Molar Mass, **μ [g/mol]** is the mass of 1 mole of a given substance. To find it, you need to add up **atomic weights** of all the atoms in a single molecule. Those can be found in Periodic Table.

Example:

$$\mu_{H_2 0} = (2+16)\frac{g}{mol} = 18\frac{g}{mol}$$

	Volume	Mass	Amount of Substance	Number of Molecules
Symbol	**V**	**M**	**n**	**N**
Units	[m^3] or [cm^3]	[kg] or [g]	[mol]	**1**

$$\rho = \frac{M}{V}$$

$$n = \frac{M}{\mu}$$

$$\nu = \frac{N}{N_A}$$

Greek 'rho'

Greek 'mu'

Ideal Gas Law (revisited)

Classical version (with moles)

$$PV = nRT$$

Here $n = \frac{m}{\mu}$ is amount of substance (in moles),

$R \approx 8.3 \frac{J}{mol \cdot K}$ is called Universal Gas Constant.

"Molecular" version

$$PV = Nk_bT$$

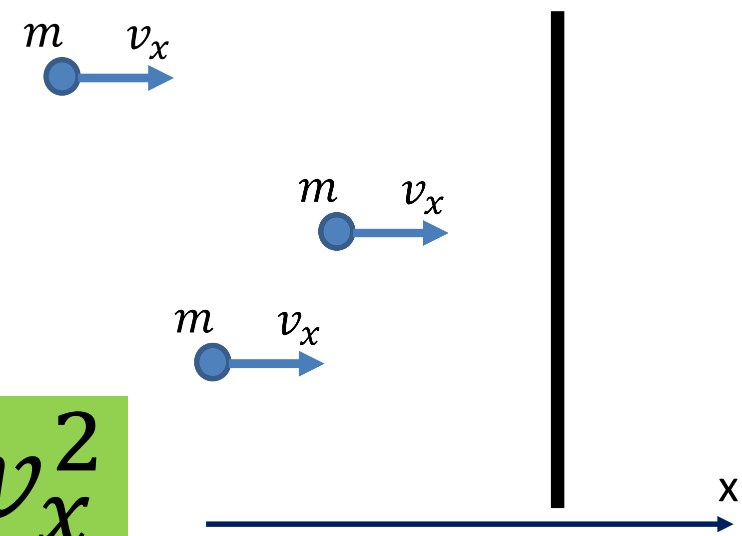
Here $N = n \cdot N_A$ is number of molecules,

$k_B = \frac{R}{N_A} \approx 1.36 \cdot 10^{-23} \frac{J}{K}$

is called Boltzmann Constant

Kinetic energy per degree of freedom is

$$\frac{mv_x^2}{2} = \frac{k_bT}{2}$$



$$PV = Nmv_x^2$$

Results of Boltzmann's kinetic theory: pressure of molecules bombarding the wall.

Problem

Find the specific heat, $C=\Delta Q/\Delta T$, ***per 1 mole*** *(not per 1 kg!)*of a gas at constant volume. Note that if volume is fixed, no work is being done, so all added heat converts to the of kinetic energy. As we know kinetic energy is $\frac{k_b T}{2}$ per degree of freedom. You'll need to account for two types of degrees of freedom: translational (going along x,y,z direction) and rotational. Consider the following gases:

a) He. Since helium is a noble gas, its molecule is made of a single atom (hence, no rotational degrees of freedom).
b) O_2 (how many rotational degrees of freedom?).
c) H_2O .