- **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

$$PV = Nk_bT$$

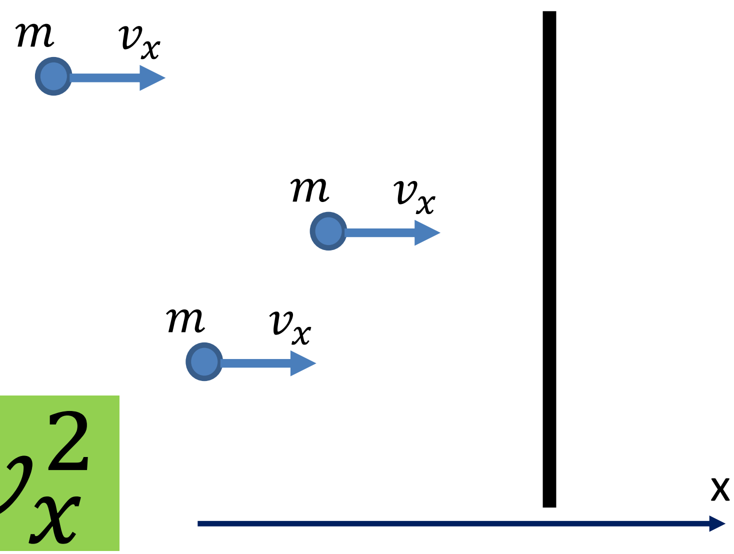
Here $N = n \cdot N_A$ is number of molecules,

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

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 1

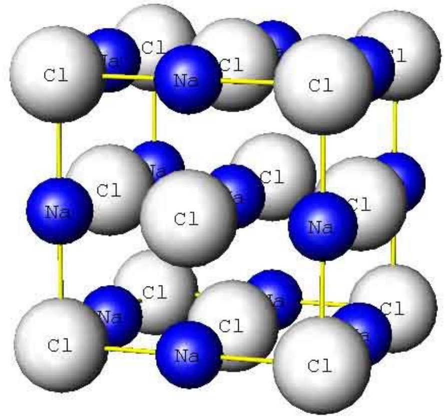


Table salt (or Sodium Chloride, *NaCl*) is made of Sodium (Na+) and Chlorine (Cl−) ions held together by static electricity. Ions are atoms with extra or missing electrons (in this case, Chlorine steals one electron from Sodium). These ions form a cubic crystal as the one shown in the Figure. Find the distance '**a**' between the centers neighboring ions (Na and Cl), in cm, if the density of *NaCl* is ρ=2.16 g/ml.
Hint: you already know hiw to find the number of Na and Cl ions in any volume, i.e 1 ml=1cm^3. On the other hand, each ions occupies one cube of volume **a**^{3}.

Problem 2

What is the number of molecules in a room of size 4x5x2.5 meters, at normal conditions (*T=300K, P= 100kPa*)? Find the total kinetic energy of these molecules, associated with motion in all three directions (i.e. account for 3 degrees of freedom per molecule, ignore rotation).