Distribution of Molecular Speeds

- The reason to consider speed & not velocity is that many physical properties of gases are dependent only on speed of gas particles & not on direction of motion.
- Only the magnitudes of velocity or speed is of interest.
- Maxwell distribution describes the probability of observing a particle within a given range of speeds. Entire distribution knowledge is seldom required when comparing property of gases.
- Representative quantity of this distribution as to how distribution changes as a function of molar mass or temperature are more useful.
- In derivation of kinetic gas equation, it was considered that all molecules of a gas at a given temperature are moving with a constant root mean square speed. Actually, all molecules do not have same speed because they are continually colliding with each other & with sides of container. During collisions, a transfer of momentum takes place between molecules. Due to this, some molecules move with increased speeds while others have low speeds or may even stop completely.
- When a steady state is attained, each molecule will experience a continuous change

in speed. So individual speeds of molecules are not known. One can only obtain a distribution of molecular speeds at a given temperature.

Thus collisions result in a redistribution of both energy & speeds.

Speeds will vary from '0' to high values.

- Maxwell & Boltzmann utilizing probability considerations have shown that actual distribution of molecular speeds depends on temperature & molar mass of gas.

- Expression derived as:

$$\frac{dn_c}{n'} = 4\pi \left(\frac{m}{2\pi kT}\right)^{3/2} \exp\left(\frac{-mc^2}{2kT}\right) c^2 dc \quad -(1)$$

↙ Fraction of total number of molecules having speeds between c & $c+dc$

m = mass of gas molecules.

$$\frac{1}{n'}\frac{dn_c}{dc} = 4\pi \left(\frac{m}{2\pi kT}\right)^{3/2} \exp\left(\frac{-mc^2}{2kT}\right) c^2$$

↙ Fraction of molecules in the range c & $c+dc$ per unit interval of speed. This is probability of finding molecules having speeds between c & $c+dc$ & it depends only on

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temperature according to relation (1.), therefore, for a given temperature, this fraction has a constant value.

9 am
10 am
11 am
Noon
1 pm
2 pm
3 pm