

Models of A gas

- a gas consists of a large number of very small thing. flying about randomly.

Not necessary to assume particles are

- strictly point like
- small compared to the average distance.

Hard Spheres Model

- particles have some finite sizes.
- interaction limited to collisions.

L : diameter of the container

s : average separation between the molecules

r_c : radius of a single molecule

λ : average distance travelled by any given molecules before hitting another

$$L \gg \lambda \gg s \gg r_c$$

eg. $10^{-2} \gg 10^{-7} \gg 3 \times 10^{-9} \gg 10^{-10}$

The inequality may not hold when the density of the gas is very high or low.

Internal states

A molecule can rotate and vibrate.

Internal states can be allowed for quite easily by averaging.

The Quantum Limit.

- whether quantum theory is needed depends on the degree of approximation.
- At thermal equilibrium or around it, the classical treatment yields accurate results as long as
the particles are not so densely packed.

$$\text{Thermal energy} = k_B \cdot T$$

$$\text{Momentum: } p = \sqrt{2mk_B \cdot T}$$

$$\text{De Broglie wavelength: } \lambda = \frac{h}{p} = \frac{2\pi \hbar}{\sqrt{2mk_B \cdot T}}$$

n : the number of gas particles per unit volume

$$n\lambda^3 \ll 1$$

if this inequality holds, then Newtonian Physics is sufficient to treat the motion of the particles.