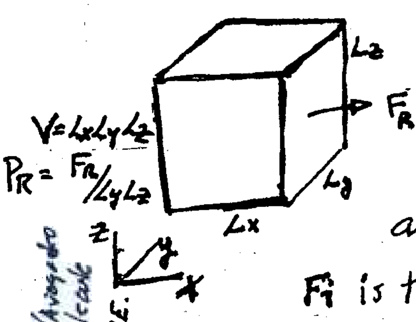
The Ideal Gas Law: $PV = nRT_A = NkT_A$, and the inference that $\frac{3}{2}kT_A = \langle KE_i \rangle$ = Avg KE. of a gas molecule. can be obtained by elementary considerations, as follows.

Take the container to be a cube L on each side. Assume that each gas particle has speed v and all velocity directions equally probable. Then

(1) Compute the AVERAGE force exerted by the particles hitting the Right side of the cube & Divide this Avg. Force by L^2 = Area of Right Face to obtain $P = |\vec{F}_{AV}|/L^2 = |\vec{F}_R|/L_y \cdot L_z$, as follows.

(2) To compute $|\vec{F}_{AVG}|$, consider one molecule of gas, which has x-component of $\vec{v}$ of $+v_x$ as it hits the RIGHT face. It rebounds elastically with a final x-component of velocity, $-v_x$. Its x-component of momentum is changed by $\Delta p_x = -mv_x - (+mv_x) = -2mv_x$. and this requires an impulse $\bar{F}_i \Delta t = -2mv_x$, where $\bar{F}_i$ is the force exerted by the wall on the ith molecule during the collision. And the force on the face is $\bar{F}_i = +2mv_x/\Delta t$, by N's III Law.



(3) Compute the rate, R, at which molecules strike the right face, assuming that there are N molecules in the box. During a small interval Δt, all of the molecules within $v_x \Delta t$ of the right face which are travelling to the RIGHT (as ½ are at any moment) will hit the face. Therefore $R\Delta t = \frac{N}{2} \cdot \frac{v_x \Delta t}{L}$ molecules hit the RIGHT face during Δt. [The fraction of such molecules is $\frac{R\Delta t}{N} = \frac{v_x \Delta t}{2L}$.]

(4) The average force on the right face during a small interval Δt is the product of $\bar{F}_i$ for one molecule times the No of molecules hitting the wall during Δt: $F_{AVG} = (\bar{F}_i)$ (No. hits) $= \left(\frac{2mv_x}{\Delta t}\right)\left(\frac{N}{2}\frac{v_x \Delta t}{L_x}\right) = \frac{N}{L_x} m v_x^2$

& The Pressure is $\frac{F_{AVG}}{L_y L_z} = P = \frac{1}{L_y \cdot L_z \cdot L_x} N m v_x^2 = \frac{1}{V} N(m v_x^2)$: $PV = N(\overline{m v_x^2}) = NkT_A = nRT_A$

(5) In this way $kT_A = \overline{m v_x^2} = \frac{2}{3}\left[\overline{\frac{m}{2}(v_x^2 + v_y^2 + v_z^2)}\right] = \frac{2}{3}(\overline{KE})$; Thus If the average $\overline{KE}$ of a molecule $\overline{KE} = \frac{3}{2}kT_A$, the IDEAL GAS LAW follows.

Recall { N = no of gas molecules in box. n = no. of MOLES of GAS in box = $N/N_{Avogadro}$; k = Boltzmann's gas constant per molecule; $R = N_{Avogadro} \cdot k$ = gas constant per MOLE.