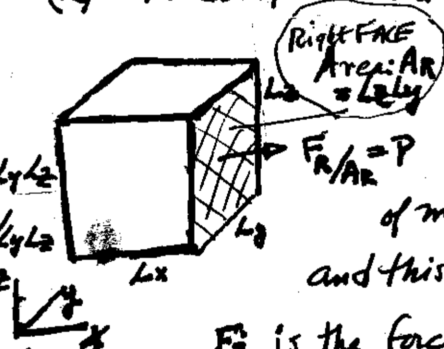
The Ideal Gas Law: $PV = nRT_A = NkT_A$,
and the inference that $\frac{3}{2}kT_A = \langle KE_i \rangle$ = Avg K.E. of a gas molecule
can be obtained by elementary considerations, as follows.
Take the container to be a cube L on each side.
Assume that each gas particle has speed v and all
velocity directions 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 $P = |\vec{F}_{AV}|/A_R = |\vec{F}_R|/L_y \cdot L_z$,
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 $\vec{F}_i \Delta t = -2mv_x$, where
$\vec{F}_i$ is the force exerted by the wall on the ith molecule during
the collision. And the force on the face is $\vec{F}_i = +2mv_x/\Delta t$, by N's III Law.



Recall $\left\{ \begin{array}{l} N = \text{no of gas molecules in box.} \\ n = \text{No. of MOLES of gas in box} = N/N_{Avogadro} \\ k = \text{Boltzmann's gas constant per molecule} \\ R = N_{Avogadro} \cdot k = \text{gas constant per MOLE.} \end{array} \right.$

(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 $\vec{F}_i$ for one molecule times the No of molecules hitting during
Δt: $F_{AVG} = (\vec{F}_i)(\text{No. hits}) = \left(\frac{2mv_x}{\Delta t}\right)\left(\frac{N}{2}\frac{v_x \Delta t}{L_x}\right) = \frac{N}{L_x} m v_x^2$

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

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