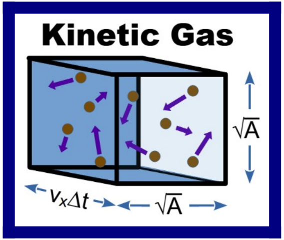
Ideal Gas Law

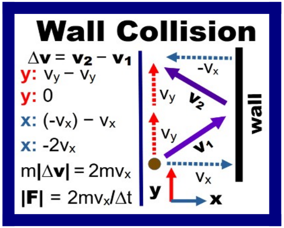
D Bernoulli
1700 – 1782



In 1738, Daniel Bernoulli, published his kinetic theory of gases. Molecules exert pressure through elastic collisions with container walls. For a gas @ absolute temperature (T) **w/particles having molecular mass** (m), **speed** (v), **kinetic energy** ($KE \equiv \frac{1}{2}mv^2$)**, the theory requires:**

a) Boltzmann constant (k_B) **relates** $\langle KE \rangle \propto \langle mv^2 \rangle = k_B T$.
b) constant motion w/elastic collisions.
c) point particles w/o interactions.

Pressure (p_A) **on container wall w/area** (A) **is force** **(F) per area of count** (N) **particles w/reversed velocity** ($2mv_x$). **An average is taken over time** (Δt).



$\frac{1}{2}N$ **particles collide w/wall** A **in time** Δt ($v_x > 0$)
Container has volume (V)**:** $V = A v_x \Delta t \Rightarrow 1/A = v_x \Delta t / V$
$p_A = \frac{1}{2}N \langle |\mathbf{F}|/A \rangle = \frac{1}{2}N \langle (2m\mathbf{v}/\Delta t) \cdot (\mathbf{v}\Delta t / V) \rangle = N \langle mv^2 \rangle / V$

Ideal Gas Law: $N \langle mv^2 \rangle = N k_B T \Rightarrow p_A V = N k_B T$

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