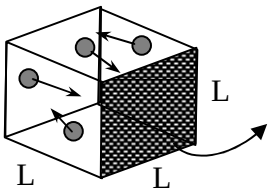
Kinetic Molecular Theory

$P = \frac{f}{A}$

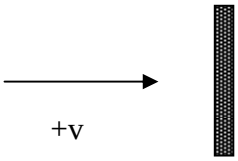


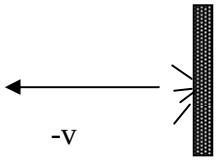
$A = L^2$ $V = L^3$

force = (force per collision)(collisions per sec per molecule)(molecules moving in the correct direction)

force per collision:

before collision: after collision: $f = m\,a = m\frac{\Delta v}{\Delta t}$





$\Delta v = (+v) - (-v) = 2v$

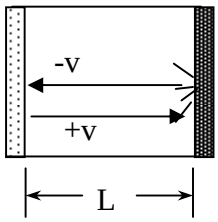
$f = 2mv$

collisions per sec

Taking a trip, want to stop periodically:

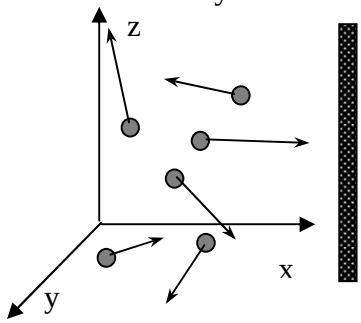
stops per hour = $\frac{\text{speed}}{\text{distance between stops}} = \frac{60\text{ mi/hr}}{60\text{ mi}} = 1$ stop/hour

collisions per second = $\frac{\text{speed}}{\text{distance between collisions}} = \frac{v}{2L}$



molecules moving in the correct direction

Molecules moving in all directions, x, y, and z. On average only 1/3 are moving along the correct axis toward or away from the wall; only 1/3 are poised to strike the wall:



On average: 1/3 are moving along the x-axis ⟷
1/3 are moving along the y axis
1/3 are moving along the z axis

for 1 mole total: $\frac{N_A}{3}$ are moving in the correct direction

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$f = (2mv)\left(\frac{v}{2L}\right)\left(\frac{N_A}{3}\right) = \frac{N_A\, m\, v^2}{3\, L}$

average over all the molecules: $f = \frac{N_A\, m\, \overline{v^2}}{3\, L}$

$P = \frac{f}{A} = \frac{N_A\, m\, \overline{v^2}}{3\, L^3} = \frac{N_A\, m\, \overline{v^2}}{3\, V}$

root mean squared speed = $u = \left(\overline{v^2}\right)^{1/2}$ $u^2 = \overline{v^2}$

$PV = {}^1/_3\, N_A\, m\, u^2$ $\varepsilon = \frac{1}{2}\, m\, u^2$ $PV = {}^2/_3\, N_A\, \varepsilon = RT$ $\varepsilon = {}^3/_2\, RT/N_A$