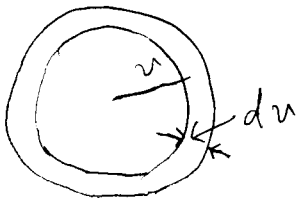
$PV = \text{const}$

$PV^{\gamma} = \text{const}$ $\quad \gamma = \frac{C_p}{C_v}$

動能 $= \frac{1}{2}mv^2$

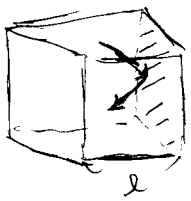


波次曼分布

$$f(v) = 4\pi N \left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} v^2 e^{-\frac{mv^2}{2k_BT}}$$

$k_B = 1.38 \times 10^{-23}$

$$\int_0^{\infty} f(v)\,dv = N$$



$\Delta p = 2mv_x \qquad \Delta t = \frac{2l}{v_x}$

$$F = \frac{\Delta p}{\Delta t} = \frac{N 2m v_x}{\frac{2l}{v_x}} = \frac{Nmv_x^2}{2l}$$

$\to v_{rms}$

$$\langle v_x^2 \rangle = \langle v_y^2 \rangle = \langle v_z^2 \rangle = \frac{1}{3}\langle v^2 \rangle$$

$$P = \frac{F}{A} = \frac{F}{l^2} = \frac{Nm\langle \frac{1}{3}v^2 \rangle}{l^3 \to V} \qquad \left(\frac{1}{3}mv^2 = \frac{2}{3}\cdot\frac{\frac{1}{2}mv^2}{\frac{3}{2}kT}\right)$$

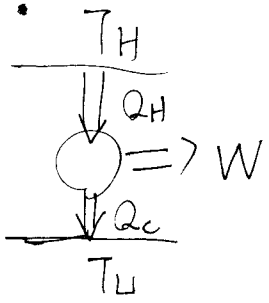
壓力

$$\Rightarrow PV = NkT = nN_AkT = nRT.$$

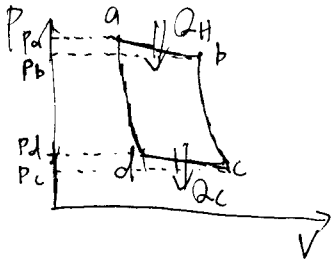
$$f'(v) = C\left[2ve^{-\frac{mv^2}{2kT}} + v^2\left(-\frac{m}{2kT}\right)e^{-\frac{mv^2}{2kT}}(2v)\right] = 0.$$

$$\Rightarrow C2ve^{-\frac{mv^2}{2kT}}\left[1 - \frac{mv^2}{2kT}\right] = 0.$$

$$\Rightarrow v = \sqrt{\frac{2kT}{m}}$$



$$\rho = \frac{|W|}{|Q_H|} = \frac{|Q_H| - |Q_C|}{|Q_H|} = 1 - \frac{|Q_C|}{|Q_H|}$$



① $a \to b$ 等溫膨脹.
② 絕熱膨脹 $b \to c$
③ 等溫壓縮. $c \to d$.
④ 絕熱壓縮 $d \to a$.

卡諾循環.

$$Q_H = \int_{V_a}^{V_b} P\,dV = \int_{V_a}^{V_b} \frac{nRT_H}{V}\,dV$$

$$= nRT_H \ln \frac{V_b}{V_a}$$

$$|Q_L| = nRT_L \frac{V_c}{V_d}$$

$$\frac{|Q_L|}{|Q_H|} = \frac{T_L}{T_H} \frac{\ln \frac{V_c}{V_d}}{\ln \frac{V_b}{V_a}} = \frac{T_L}{T_H}$$

$$\begin{cases} P_b V_b^{\gamma} = P_c V_c^{\gamma} \Rightarrow \\ P_a V_a^{\gamma} = P_d V_d^{\gamma} \Rightarrow \end{cases} \begin{cases} V_b^{\gamma-1} = V_c^{\gamma-1} \\ V_a^{\gamma-1} = V_d^{\gamma-1} \end{cases}$$

$$\rho = 1 - \frac{|Q_L|}{|Q_H|} = 1 - \frac{T_L}{T_H}. \quad \text{if 卡諾循環.}$$

entropy $dS = \frac{dQ}{T}$.