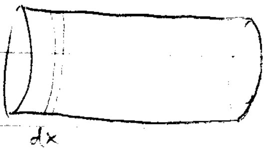
、能量 => 動能、位能、功

動量、角動量、力矩

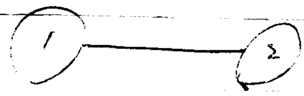
力學 N V T P: 壓力



$$dw = F\,dx = pA\,dx = p\,dV$$

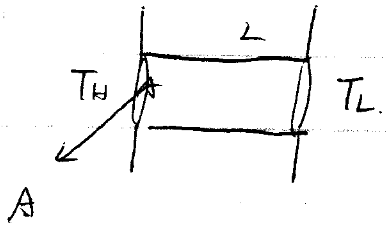
理想氣体 $PV = nRT$

$$T_B = T_A, \quad T_C = T_A \Rightarrow T_B = T_C$$

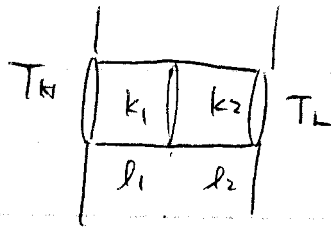


$t_1 > t_{12} > t_2$. (在 $t_1 > t_2$ 下)

傳導



$$\frac{dQ}{dt} = k\frac{A}{L}(T_H - T_L)$$



$$\frac{dQ}{dt} = k_1\frac{A}{l_1}(T_H - T_\ell)$$

$$\frac{dQ}{dt} = k_2\frac{A}{l_2}\cancel{(T_\ell - T_L)}$$

↓ 設此溫度 T_ℓ

$$\cancel{T_\ell = T_H - \frac{A}{k_1 l_1}\left(\frac{dQ}{dt}\right) \qquad \frac{dQ}{dt} = k_2\frac{A}{l_2}\left(T_H - \frac{A}{k_1 l_1}\frac{dQ}{dt} - T_L\right)}$$

$$T_\ell = T_H - \frac{l_1}{k_1 A}\left(\frac{dQ}{dt}\right) \qquad \frac{dQ}{dt} = k_2\frac{A}{l_2}\left(T_H - \frac{l_1}{k_1 A}\frac{dQ}{dt} - T_L\right)$$

$$\left(1+\frac{k_2 l_1}{k_1 l_2}\right)\frac{dQ}{dt} = \frac{k_2 A}{l_2}\left(T_H - T_C\right)$$

$$\left(\frac{k_1 l_2 + k_2 l_1}{k_1 l_2}\right)\frac{dQ}{dt} = \frac{k_2 A}{l_2}\left(T_H - T_C\right)$$

$$\frac{dQ}{dt} = \frac{k_1 k_2 A}{k_1 l_2 + k_2 l_1}\left(T_H - T_C\right)$$

$$= \frac{A}{\frac{l_2}{k_2} + \frac{l_1}{k_1}}\left(T_H - T_C\right)$$

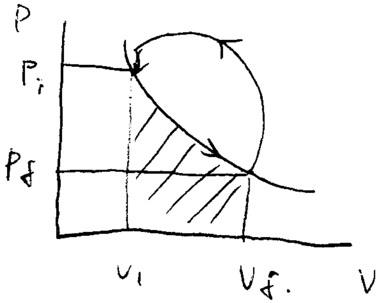
輻射 $\propto T^4$

熱力學第一定律 $dQ = dU + dW$ 在 ideal gas 下 $U = U(T)$
(能量守恆)

$\Rightarrow$ $\cancel{\Delta H}$ $\Delta Q = \Delta U + \Delta W$

$= \Delta U + P\Delta V$　　　　也代表變化跟路徑有關

$P\Delta V$ 被路徑決定



回到原点時，作的功不同

1 mole (gas) $\Rightarrow$ 22400 cm^3.

$$\frac{22400}{6\times10^{23}} = 3.7\times10^{-20} \doteq 3.2\times10^{-7} \simeq 32\text{Å}$$

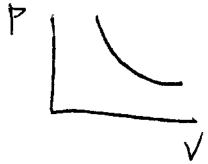
氫原子半徑 0.53Å

也可以忽略.

因此在 ideal gas 下，粒子体積可忽略。（內聚力跟距離有關）

記分欄 轉頁從此開始寫起

case 1. 等溫膨脹



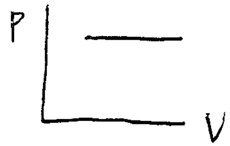
$dQ = dU + pdV$

$\Rightarrow dQ = pdV$

$\Delta Q = \int p\,dV = \int_{V_1}^{V_2} \frac{nRT}{V}\,dV = nRT \ln \frac{V_2}{V_1}$

$(pV = nRT)$

2. 等壓膨脹



$\cancel{dQ = dU +}$

比熱 $\Rightarrow$ $\frac{dQ}{dT}\Big|_V$ 体積不變 $= \frac{dU}{dT}\Big|_V + \frac{pdV}{dT}\Big|_V = 0$

$C_V = \frac{dU}{dT}$ 單原子 $U = \frac{3}{2}RT$

雙原子 $U = \frac{5}{2}RT$ 多原子 $U = \frac{6}{2}RT$

$$C_p = \frac{dQ}{dT}\Big|_p = \frac{dU}{dT}\Big|_p + \frac{dW}{dT}\Big|_p$$

$$= C_v + \frac{p\,dV}{dT} = C_v + R.$$

C_v. C_p 切互

$n=1$ 下

C_p 莫耳等压比

莫耳等体積比

~~C_v. C_p~~ ~~互~~

絶熱膨脹 $\Delta Q = 0$. $0 = C_v\,dT + p\,dV$

$pV = nRT$

$p\,dV + V\,dp = R\,dT$

$$= C_v\left(\frac{p\,dV + V\,dp}{R}\right) + p\,dV.$$

$$C = \int 0 = \gamma \int \frac{dV}{V} + \frac{dp}{p} = \gamma \ln V + \ln p \qquad pV^{\gamma} = C \qquad C=\text{constant}.$$