◆ 计算各等值过程的热量、功和内能的理论基础

（1） $pV = \frac{m}{M}RT$　（理想气体的共性）

（2）
$$\begin{cases} \mathrm{d}Q = \mathrm{d}E + p\mathrm{d}V \\ Q = \Delta E + \int_{V_1}^{V_2} p\mathrm{d}V \end{cases}$$

解决过程中能量转换的问题

（3） $E = E(T)$　（理想气体的状态函数）

（4） 各等值过程的特性 .

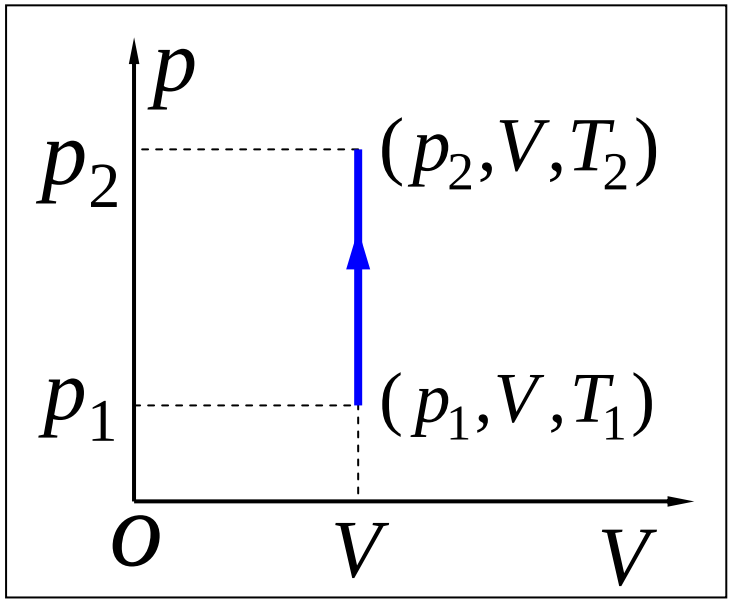
一　等体过程　定体摩尔热容

特性　$V=$ 常量

过程方程　$=$ 常量

$$\mathrm{d}V=0,\quad \mathrm{d}W=0$$

热力学第一定律　$\mathrm{d}Q_V=\mathrm{d}E$



定体摩尔热容： 1mol理想气体在等体过程中吸收的热量$\mathrm{d}Q_V$，使温度升高$\mathrm{d}T$, 其定体摩尔热容为

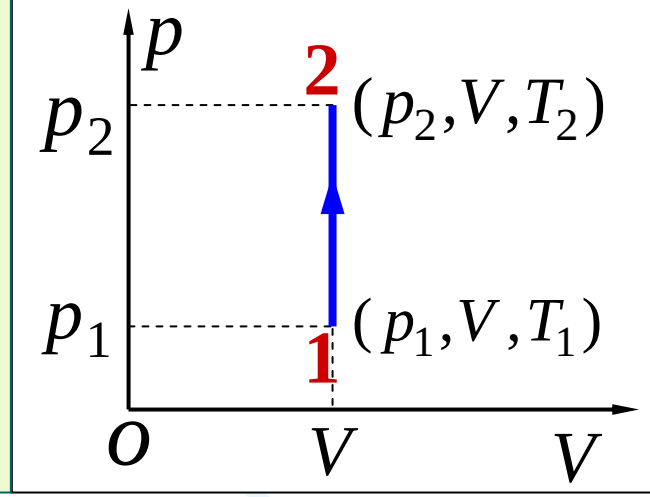
$$C_{V,\mathrm{m}}=\frac{\mathrm{d}Q_V}{\mathrm{d}T}\qquad \mathrm{d}Q_V=C_{V,\mathrm{m}}\mathrm{d}T$$

单位　$\mathrm{J\cdot mol^{-1}\cdot K^{-1}}$

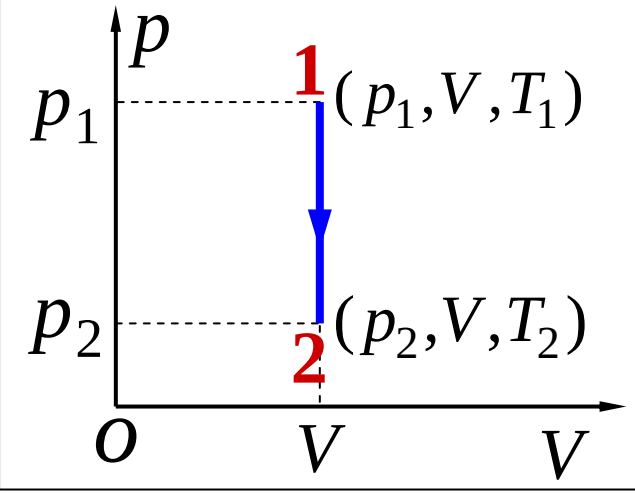
$$C_{V,\mathrm{m}}=\frac{\mathrm{d}Q_V}{\mathrm{d}T}\qquad \mathrm{d}Q_V=\mathrm{d}E=\frac{m}{M}C_{V,\mathrm{m}}\mathrm{d}T$$

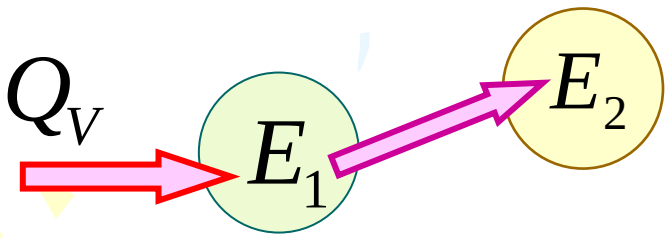
热力学第一定律　$$Q_V=\frac{m}{M}C_{V,\mathrm{m}}(T_2-T_1)=E_2-E_1$$

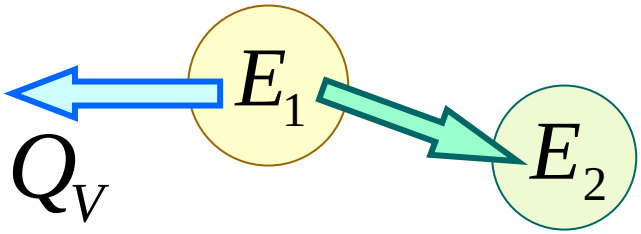
等体升压



等体降压







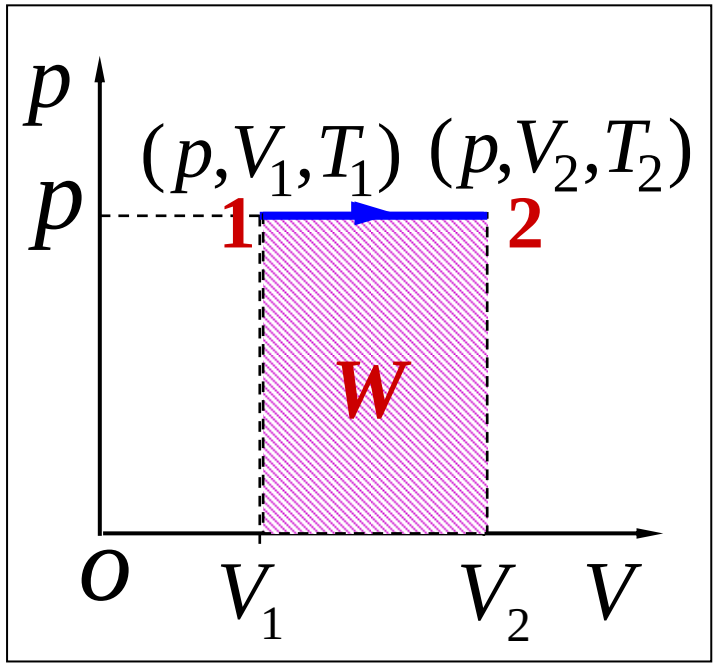
二　等压过程　定压摩尔热容

特 性　$p =$ 常量

过程方程　$VT^{-1} =$ 常量

功　$W = p(V_2 - V_1)$

热一律　$\mathrm{d}Q_p = \mathrm{d}E + \mathrm{d}W$



定压摩尔热容： 1mol 理想气体在等压过程中吸收的热量$\mathrm{d}Q_p$，温度升高 $\mathrm{d}T$，其定压摩尔热容为

$$C_{p,\mathrm{m}} = \frac{\mathrm{d}Q_p}{\mathrm{d}T} \qquad \mathrm{d}Q_p = C_{p,\mathrm{m}}\mathrm{d}T$$

$$\mathrm{d}Q_p = C_{p,\mathrm{m}}\mathrm{d}T = \mathrm{d}E + p\mathrm{d}V$$

$$\mathrm{d}E = C_{V,\mathrm{m}}\mathrm{d}T \qquad p\mathrm{d}V = R\mathrm{d}T$$

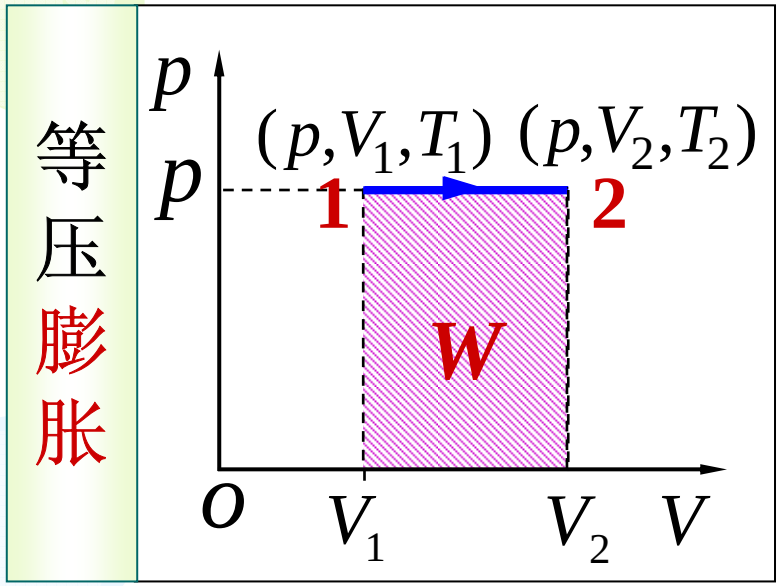
- 可得定压摩尔热容和定体摩尔热容的关系

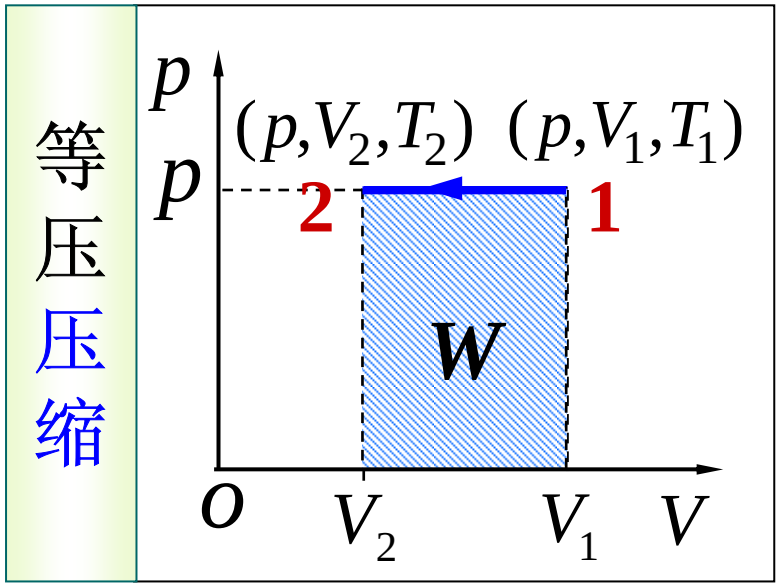
$$C_{p,\mathrm{m}} = C_{V,\mathrm{m}} + R$$

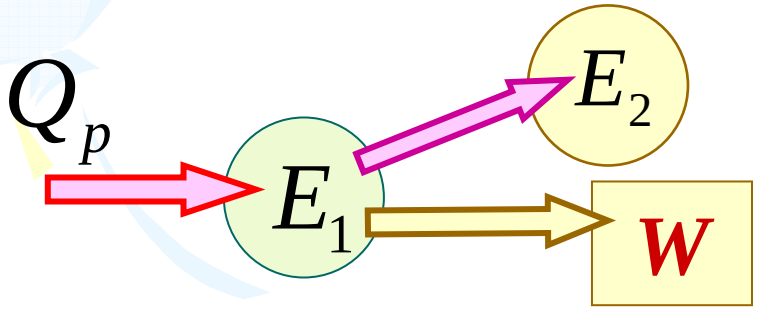
- 摩尔热容比 $\gamma = C_{p,\mathrm{m}} / C_{V,\mathrm{m}}$

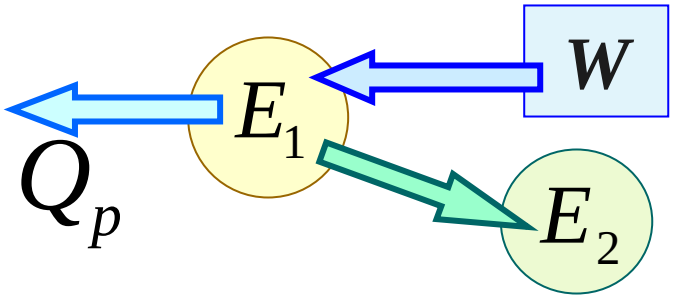
$$W = p(V_2 - V_1) = \frac{m}{M}R(T_2 - T_1)$$

$$Q_p = \frac{m}{M}C_{p,\mathrm{m}}(T_2 - T_1), \qquad E_2 - E_1 = \frac{m}{M}C_{V,\mathrm{m}}(T_2 - T_1)$$









三．比 热 容

热容　$C=\dfrac{\mathrm{d}Q}{\mathrm{d}T}$

比热容　$c=\dfrac{\mathrm{d}Q}{m\mathrm{d}T}=\dfrac{C}{m}$