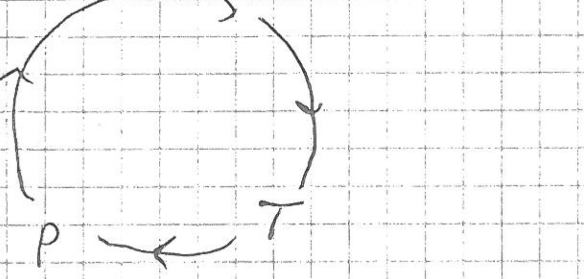
① adiabatic decompression



$\Delta S = 0$ ↑ adiabatic

Thermodynamic cyclic relation

↙ want this one: is ~~[illegible]~~ cooling.

$$* \quad \underset{a)}{\left(\frac{\partial S}{\partial T}\right)_p} \underline{\left(\frac{\partial T}{\partial p}\right)_S} \underset{b)}{\left(\frac{\partial p}{\partial S}\right)_T} = -1$$

b) Maxwell eq. $\left(\frac{\partial S}{\partial p}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_p$

a) reversible : $dS = dQ/T$ $\quad (dQ = T dS)$

isobaric : $dQ = C_p \, dT$

$$\Rightarrow \left(\frac{\partial S}{\partial T}\right)_p = \left(\frac{1}{T}\frac{dQ}{dT}\right) = \frac{C_p}{T}$$

$*$ becomes $\left(\frac{\partial T}{\partial p}\right)_S = \frac{T}{C_p}\left(\frac{\partial V}{\partial T}\right)_p$

Ideal gas : $pV = RT \Rightarrow \left(\frac{\partial V}{\partial T}\right)_p = \frac{R}{p} = \frac{V}{T}$

$$\left.\right\} \left(\frac{\partial T}{\partial p}\right)_S = \frac{V}{C_p}$$

Similar for paramagn. ($p \to -H$, $V \to M$)

$$* \quad \underbrace{\left(\frac{\partial S}{\partial T}\right)_H}_{a)} \left(\frac{\partial T}{\partial H}\right)_S \underbrace{\left(\frac{\partial H}{\partial S}\right)_T}_{b)} = -1$$

a) reversible & in const magn. field:

$$dS = dQ/T \quad ; \quad dQ = C_H \, dT$$

$$\Rightarrow \left(\frac{\partial S}{\partial T}\right)_H = \frac{C_H}{T}$$

b) Maxwell eq. corresponding to $\frac{\partial T}{\partial}$

$$\left(\frac{\partial S}{\partial p}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_p$$

is

$$\left(\frac{\partial S}{\partial H}\right)_T = +\left(\frac{\partial M}{\partial T}\right)_H.$$

$*$ becomes

$$\left(\frac{\partial T}{\partial H}\right)_S = -\frac{T}{C_H}\left(\frac{\partial M}{\partial T}\right)_H.$$

So

$$dT = -\frac{T}{C_H} \cdot \left(\frac{\partial M}{\partial T}\right) dH.$$

$$M = \chi \cdot V \cdot H \quad ; \quad \chi = \frac{C}{T}.$$

$$M = \frac{CVH}{T} \qquad \frac{\partial M}{\partial T} = -\frac{CVH}{T^2}.$$

$$dT = -\frac{T}{C_H}\left(-\frac{CVH}{T^2}\right) dH.$$

$$T\,dT = \frac{CV}{C_H} \cdot H\,dH.$$

$$\int_{T_i}^{T_f} T\,dT = \frac{CV}{C_H}\int_H^0 H\,dH.$$

$$T_f^2 - T_i^2 = -\frac{CV}{C_H} \cdot H^2$$

$$T_f^2 = T_i^2 - \frac{CV}{C_H} H^2 < T_i^2.$$