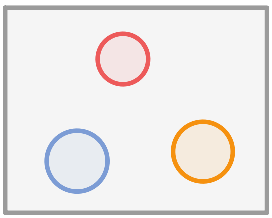
thus. $(T_f)_{min} = \sqrt{T_{10} T_{20}}$

$\rightarrow W_{max} = C(T_{10} + T_{20} - 2\sqrt{T_{10} T_{20}})$

Another example.



$T_1 \quad T_2 \quad T_3$

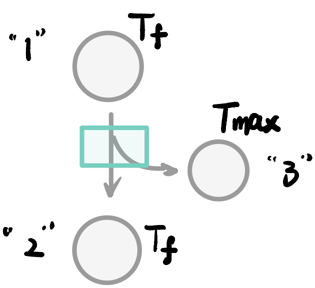
All sys follow.

$U = CT$

$S = S_0 + C \ln \frac{U}{U_0}$

$T_1 = 300K, \quad T_2 = 350K, \quad T_3 = 400K.$

by heat transfer among them, one of them could be raised to the Highest T. independent the final T of the other two. Q: what's T_{max} for that one?



1> Energy conservation:

$$\Delta U_{total} = 0$$

$$= \cancel{C}T_{max} + \cancel{C}T_f + \cancel{C}T_f - \cancel{C}(T_1 + T_2 + T_3)$$

$$T_{max} + 2T_f = T_1 + T_2 + T_3 = 10.5$$

(use "100K" as unit)

2> Entropy change ≥ 0

$\Delta S_{total} \geq 0 \qquad \Delta S_{total} = \Delta S_1 + \Delta S_2 + \Delta S_3$

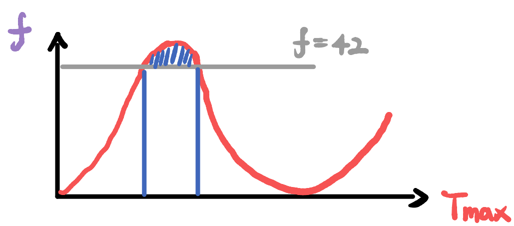
$$= \underbrace{(S_f + S_f + S_{max})}_{\text{total final}} - \underbrace{(S_{10} + S_{20} + S_{30})}_{\text{total initial}}$$

$$= C \ln \underbrace{\frac{T_f^2 T_{max}}{T_1 \cdot T_2 \cdot T_3}}_{\geq 1} \geq 0$$

$\rightarrow T_f^2 T_{max} \geq T_1 \cdot T_2 \cdot T_3 \quad (3 \times 3.5 \times 4 = 42)$

$\rightarrow$ Energy conservation: $T_f = 5.25 - T_{max}/2$

$$\underbrace{(5.25 - T_{max}/2)^2 \, T_{max}}_{f(T_{max})} \geq 42$$



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2. Quasi-Static Process and reversibility.

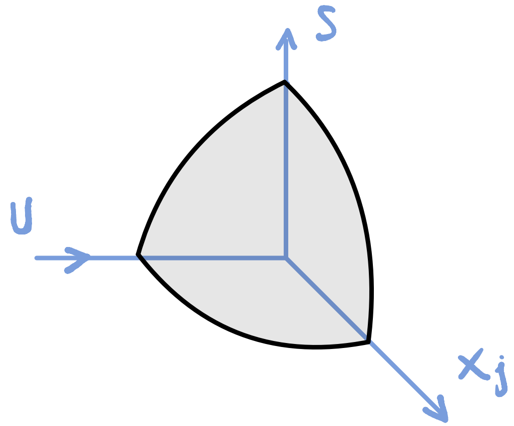
Fundamental eq. defines a thermo. sys.

$\downarrow$

$S = S(U, V, N_1, N_2, \cdots N_r)$

$\downarrow$

can be geometrically presented in thermodynamic configuration space *.



$$\left(\frac{\partial S}{\partial U}\right)_{\cdots x_j \cdots} \equiv \frac{1}{T} > 0$$

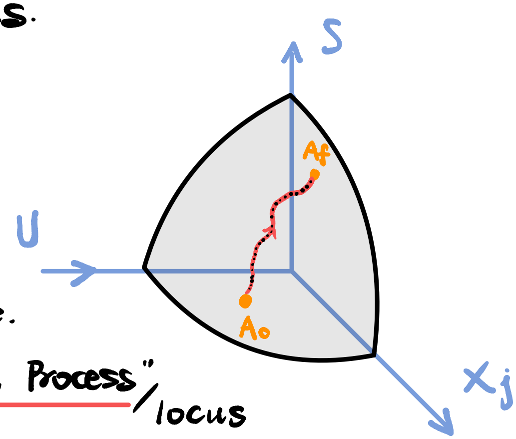
*. each coordinate corresponds to one extensive variable.

*. any point on the surface represents an equilibrium state.

2-1. Quasi-Static Process.

A_0 : initial state.

A_f: final state.



curve $A_0 - A_f$ on $S(U, \cdots x_j \cdots)$ surface.

is a "Quasi-Static Process" / locus

idealized concept. : defined by a dense succession of equilibrium states.

*. points on the surface → equilibrium.

NOT on the surface → nonequilibrium.

*. Equilibrium is maintained by certain constraints.

removal of constraints permit the change from $A_0 \rightarrow A_f$.

* Although A_0 & A_f are equilibrium states.

$A_0 \to A_f$ May NOT follow an equilibrium path.

$\Updownarrow$

Quasistatic process.

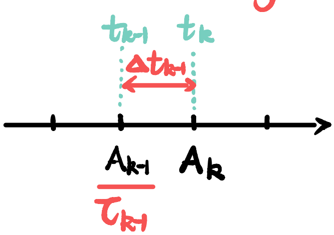
*. Real process:

a temporal succession of equilibrium and non-equilibrium states.

*. However it's possible to construct the real process that approximate a given quasi-static process.:

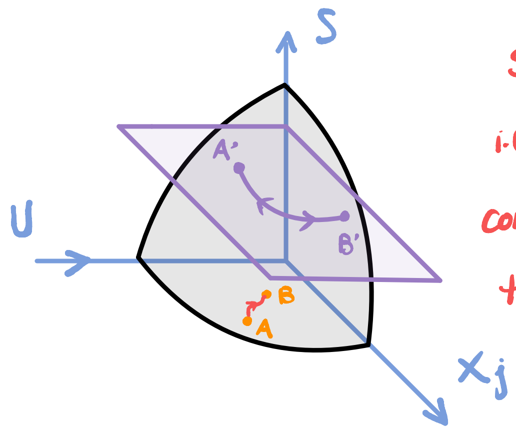
1> $A_0 - A_f$ should be divided into numerous infinitesimally small segments. each end point (A_k) should be on the surface.

$S = S(U, V, N, \cdots)$



2> the waiting time Δt_{k-1} before removing the constraints at A_{k-1} should be longer than the relaxation time τ_{k-1} required by the sys to establish equilibrium.

2-2. Reversibility. (Postulate II)



*. For $A \to B$ to occur

$S(A) > S(B)$

i.e. A & B after removing constraints has directionality.

the reverse process is not possible

i.e.. $A \to B$ process after removing constraints is irreversible.

*. The quasi-static process in which the increased Entropy is vanishingly small is called a reversible process. $S(A') \simeq S(B')$

Q: is the reversible path unique?