

Entropy:

Wednesday • December

08

WK 50 (342-023)

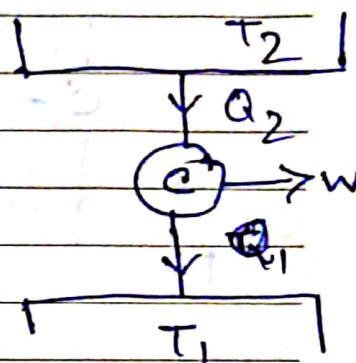
□ Carnot Th:

$$\eta \leq \eta_c$$

Equal only in the case of reversible

$$\Rightarrow 1 - \frac{Q_2'}{Q_2} \leq 1 - \frac{Q_2}{Q_2}$$

$$\Rightarrow \frac{Q_1'}{Q_2'} \geq \frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$



$$\Rightarrow \frac{Q_1'}{T_1} - \frac{Q_2'}{T_2} \leq 0$$

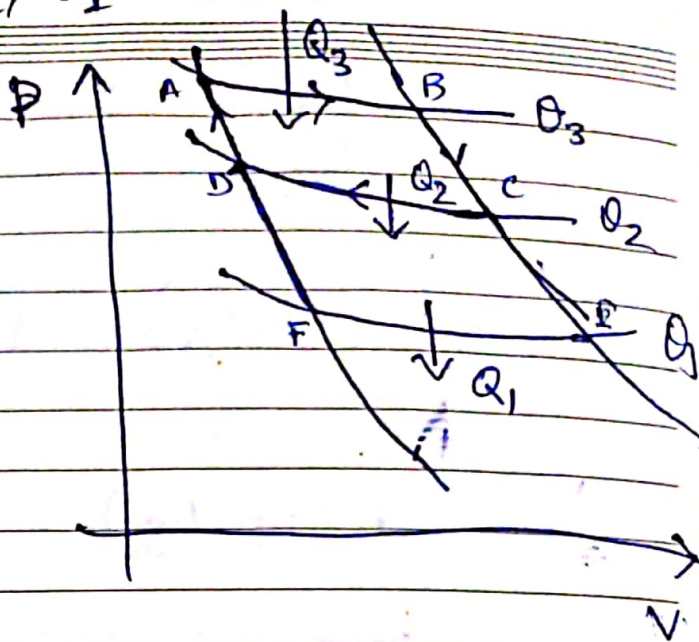
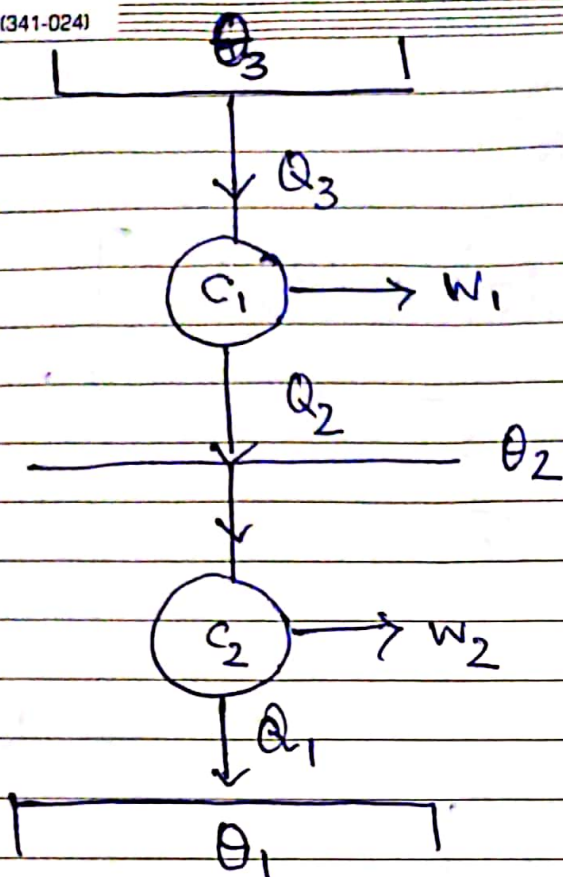
$$\Rightarrow \sum \frac{Q}{T} \leq 0$$

Equal for reversible only.

07

WK 50 (341-024)

December • Tuesday

Absolute Temp: $\theta_3 > \theta_2 > \theta_1$ 

~~$$\eta_1 = 1 - \frac{Q_2}{Q_3} = 1 - \frac{\theta_2}{\theta_3} = f(\theta_2, \theta_3)$$~~

$$\eta_1 = 1 - \frac{Q_2}{Q_3} = 1 - \frac{\theta_2}{\theta_3} = f(\theta_2, \theta_3)$$

$$\Rightarrow \frac{Q_2}{Q_3} = f(\theta_2, \theta_3)$$

$$\eta_2 = 1 - \frac{Q_1}{Q_2} = 1 - \frac{\theta_1}{\theta_2} \Rightarrow \frac{Q_1}{Q_2} = f(\theta_1, \theta_2)$$

$$\Rightarrow \frac{Q_1}{Q_3} = f(\theta_1, \theta_3)$$

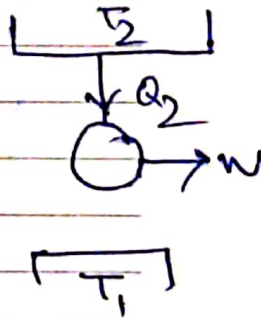
$$\frac{Q_1}{Q_3} = \frac{Q_1}{Q_2} \cdot \frac{Q_2}{Q_3}$$

$$\Rightarrow \boxed{f(\theta_1, \theta_3) = f(\theta_1, \theta_2) f(\theta_2, \theta_3)}$$

$$f(\theta_1, \theta_2) = \frac{T(\theta_1)}{T(\theta_2)}$$

$$\boxed{T_1 = T(\theta_1)}$$

$$\Rightarrow \boxed{\frac{Q_2}{Q_1} = \frac{T_2}{T_1}}$$



$$\Rightarrow Q_1 \propto T_1$$

$$\eta = 1 - \frac{T_1}{T_2}$$

$$\Rightarrow T_1 \rightarrow 0 \Rightarrow Q_1 \rightarrow 0 \Rightarrow \boxed{\eta = 1}$$

\Rightarrow 2nd Law is violated.

05

December • Sunday

WK 49 (339-026)

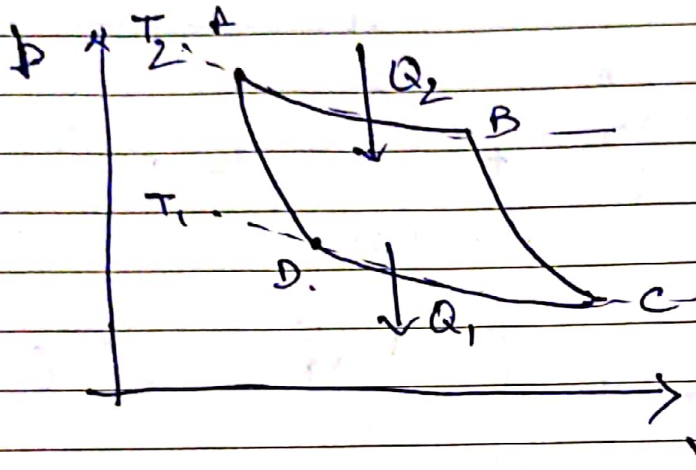
December - 2021

M	T	W	T	F	S	S	M	T	W	T	F	S	S
		1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31									

$$\oint \frac{dQ}{T} = 0$$

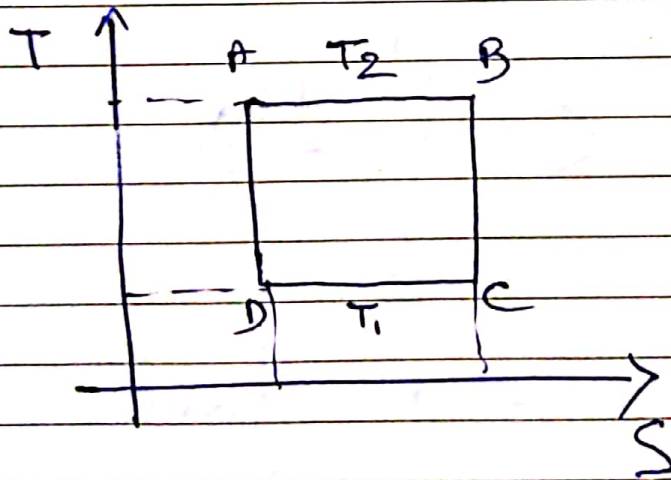
$$\oint d\sigma = 0.$$

$$d\sigma \geq \frac{dQ_r}{T}$$



$$S_B - S_A = \text{[scribble]}$$

$$= S_C - S_D$$



Clausius inequality:

$$\eta_{irr} \leq \eta_{re}$$

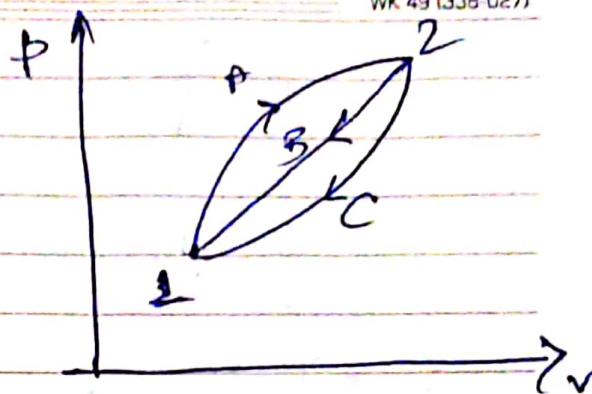
$$\boxed{\oint \frac{dQ}{T} \leq 0}$$

2021

Irreversible Process:

A, B \Rightarrow reversible

C \Rightarrow irreversible



$$\oint \frac{dQ_r}{T} = 0 = \int_1^2 \frac{dQ_r^A}{T} + \int_2^1 \frac{dQ_r^B}{T} = 0$$

$$\oint \frac{dQ}{T} = \int_1^2 \frac{dQ_r^A}{T} + \int_2^1 \frac{dQ_r^C}{T} < 0$$

$$\Rightarrow \int_2^1 \frac{dQ_r^C}{T} < \int_2^1 \frac{dQ_r}{T}$$

However Entropy is a state func

$$\Rightarrow S_1 - S_2 = \int_2^1 \frac{dQ_r}{T} = \int_2^1 dS_B = \int_2^1 dS_C$$

$$\Rightarrow \int_2^1 dS_C > \int_2^1 \frac{dQ_r}{T}$$

$$\Delta S \gg \frac{dQ}{T}$$

equal only for rev.

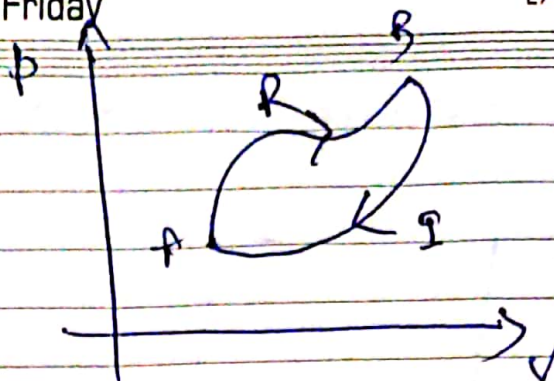
03

December • Friday

WK 49 (337-028)

December - 2021

M	T	W	T	F	S	S	M	T	W	T	F	S	S
		1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31									



From Clausius inequality we have

$$\oint \frac{dQ}{T} \leq 0$$

$$\int_A^B \frac{dQ_r}{T} + \int_B^A \frac{dQ}{T} \leq 0$$

$$\Rightarrow \int_B^A \frac{dQ}{T} \leq \int_B^A \frac{dQ_r}{T}$$

$$\Rightarrow dS = \frac{dQ_r}{T} \geq \frac{dQ}{T}$$

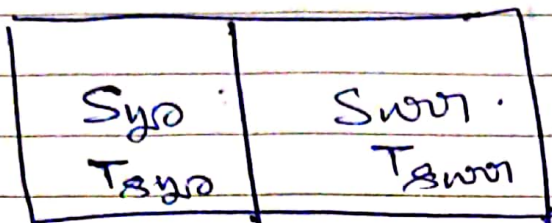
For Thermally isolated system $dQ = 0$.

$$\Rightarrow dS \geq 0$$

Entropy of an thermally isolated system either staying same or increasing.

\Rightarrow Entropy of an isolated system \rightarrow maximum

Principle of increase of entropy:



dQ flow from system \rightarrow surrounding

from Clausius inequality:

$$\Delta S_{\text{sys}} \geq -\frac{dQ}{T_{\text{sys}}}$$

$$\Delta S_{\text{surr}} = +\frac{dQ}{T_{\text{surr}}}$$

$$\Delta S_{\text{U}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$$

$$\geq -\frac{dQ}{T_{\text{sys}}} + \frac{dQ}{T_{\text{surr}}} = dQ \left(-\frac{1}{T_{\text{sys}}} + \frac{1}{T_{\text{surr}}} \right)$$

$$T_{\text{surr}} \geq T_{\text{sys}}$$

$$\Delta S_{\text{U}} \geq 0$$

01

December • Wednesday

WK 49 (335-030)

December - 2021

M	T	W	T	F	S	S	M	T	W	T	F	S	S
		1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24	25	26
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First Law:

$$dU = \delta Q + \delta W$$

$$dU = TdS - PdV \Rightarrow \text{Holds for irreversible processes also}$$

$$U = U(S, V)$$

$$dU = \left(\frac{\partial U}{\partial S} \right)_V dS + \left(\frac{\partial U}{\partial V} \right)_S dV$$

$$\left. \begin{aligned} T &= \left(\frac{\partial U}{\partial S} \right)_V \\ P &= - \left(\frac{\partial U}{\partial V} \right)_S \end{aligned} \right\} \Rightarrow \frac{P}{T} = \left(\frac{\partial S}{\partial V} \right)_U$$

2021