ENTROPY

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Entropy

abdca
carnot cycle

$$\eta = \frac{Q_1 - Q_2}{Q_1} = \frac{T_1 - T_2}{T_1}$$

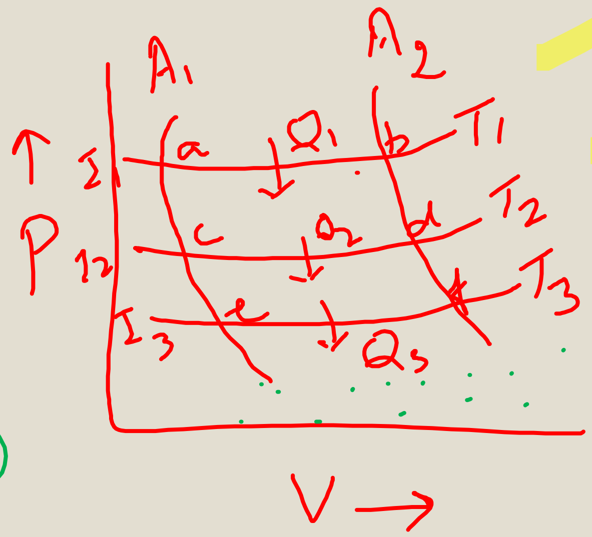
$$\Rightarrow 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$$

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

$$\Rightarrow \frac{Q_1}{T_1} = \frac{Q_2}{T_2} \quad \text{— (1)}$$

cdfec

$$\frac{Q_2}{T_2} = \frac{Q_3}{T_3} \quad \text{— (2)}$$



$$\frac{Q_1}{T_1} = \frac{Q_2}{T_2} = \frac{Q_3}{T_3} = \dots = \text{Const}$$

Change in Entropy in Reversible Process

- The Carnot Cycle

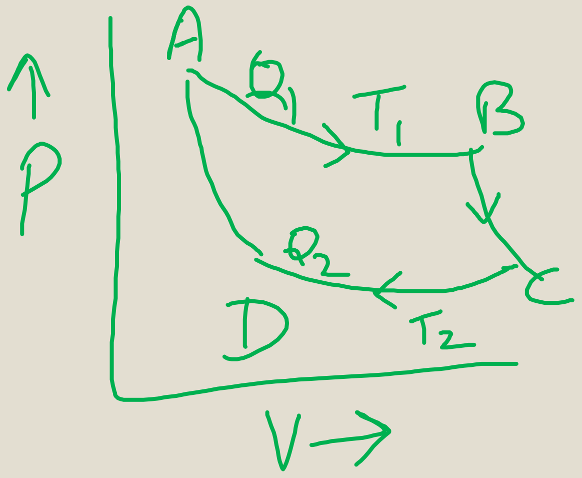
(i) gain in entropy = $\frac{Q_1}{T_1}$ — (1)

(ii) change in entropy = 0 — (2)

(iii) decrease in entropy = $\frac{Q_2}{T_2}$ — (3)

(iv) No change in entropy

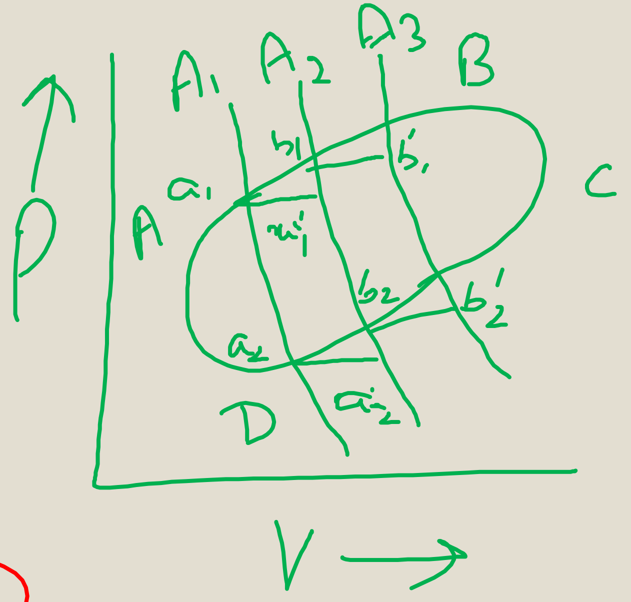
Net change in entropy = $\frac{Q_1}{T_1} - \frac{Q_2}{T_2} = 0$



- Any Reversible Cycle

∴ Net change in entropy for this elementary cycle

$$a_1 a_1' a_2' a_2 a_1 = \frac{dQ_1}{T_1} - \frac{dQ_2}{T_2} = 0 \quad \text{--- (1)}$$



$$\Sigma\left(\frac{dQ_1}{T_1} - \frac{dQ_2}{T_2}\right) = 0$$

$$\Rightarrow \boxed{\oint \frac{dQ}{T} = 0} \quad \text{--- (2)}$$

Clausius theorem

CLAUSIUS INEQUALITY

The efficiency of the reversible engine is

$$\eta_r = 1 - \frac{T_2}{T_1} \quad \text{--- (1)}$$

Eff. of Irreversible engine

$$\eta_I = 1 - \frac{Q_2}{Q_1} \quad \text{--- (2)}$$

Acc to carnot theorem

$$\eta_I < \eta_r$$

$$\Rightarrow \left(1 - \frac{Q_2}{Q_1}\right)_I < 1 - \frac{T_2}{T_1}$$

$$\Rightarrow \left(\frac{Q_2}{Q_1}\right)_I > \frac{T_2}{T_1}$$

$$\frac{(Q_2)_I}{T_2} > \frac{(Q_1)_I}{T_1} \quad \text{--- (3)}$$

$$\Rightarrow \oint_I \frac{dQ}{T} = \frac{(Q_1)_I}{T_1} - \frac{(Q_2)_I}{T_2} < 0$$

$$\Rightarrow \boxed{\oint_I \frac{dQ}{T} < 0}$$

$$\oint \frac{dQ}{T} > 0 \quad \times$$

$$\boxed{\oint \frac{dQ}{T} \leq 0} \quad \text{--- (4)}$$

THANK YOU