CARNOT CYCLE :-

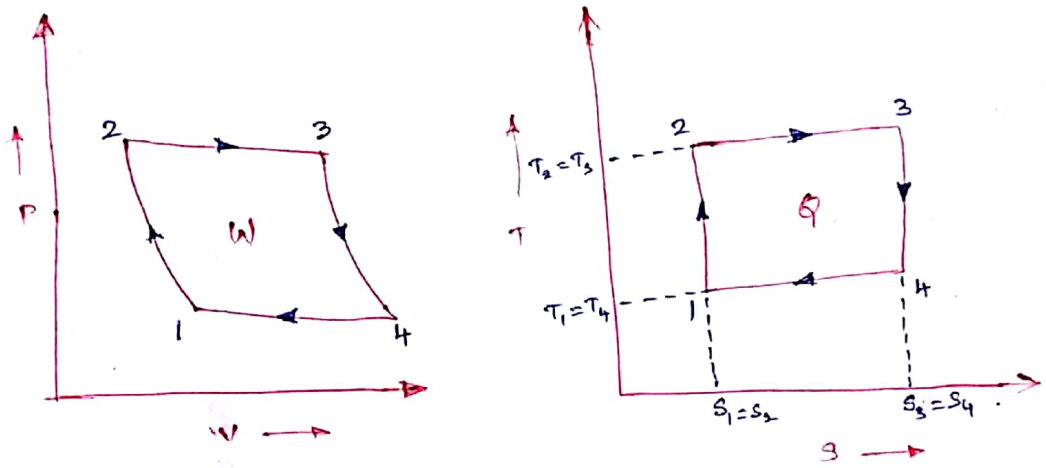
It is also called as constant temperature cycle. It consist of four processes such as two isentropic or reversible adiabatic and two isothermal process.

Process 1-2 → Isentropic compression process

2-3 → constant temperature heat addition.

3-4 → Isentropic Expansion process

4-1 → constant temperature heat rejection.



Process 1-2. (Isentropic compressed process)

During this process, both the pressure and temperature increase from P_1 to P_2 and T_1 to T_2. Volume decreases from V_1 to V_2. There is no heat added or rejected during this process. $(S_1 = S_2)$.

Process 2-3. (Constant temperature heat addition)

Heat is supplied to the fluid at constant temperature. There is not change in temperature $(T_2 = T_3)$. But volume and entropy increase from V_2 to V_3 and S_2 to S_3. pressure decrease from P_2 to P_3.

$$dQ = T.\, ds. \quad (T_2 = T_3)$$

Process 3-4. (Isentropic expand process)

During this process, both pressure and temperature decrease from P_3 to P_4 and T_3 to T_4. But entropy remains constant $S_3 = S_4$.

Process 4-1 (constant temperature heat rejection)

During this process, heat is rejected isothermally from the fluid and attains its initial position. The fluid completes one full cycle.

$$dQ_{4-1} = T.\, ds. \quad (T_1 = T_4)$$

Work done W = heat supplied − heat rejected.

$$W = T_2 \cdot ds - T_1 \cdot ds.$$

$$W = (T_2 - T_1)\, ds.$$

Efficiency $\eta = \frac{W}{Q_s} = \frac{(T_2 - T_1)ds}{T_2 \cdot ds}$.

$$\eta_{carnot} = \frac{T_2 - T_1}{T_2} = \frac{T_H - T_L}{T_H}.$$

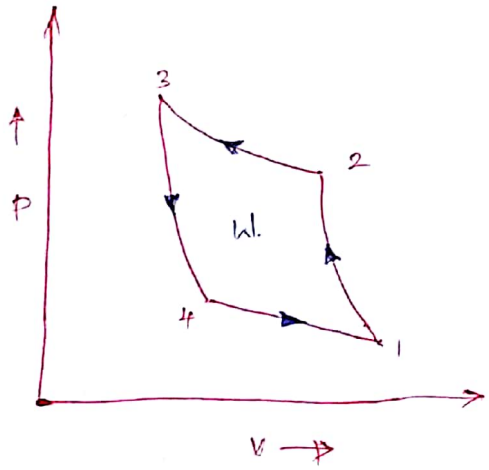
$\because$ $T_2 = T_H$.

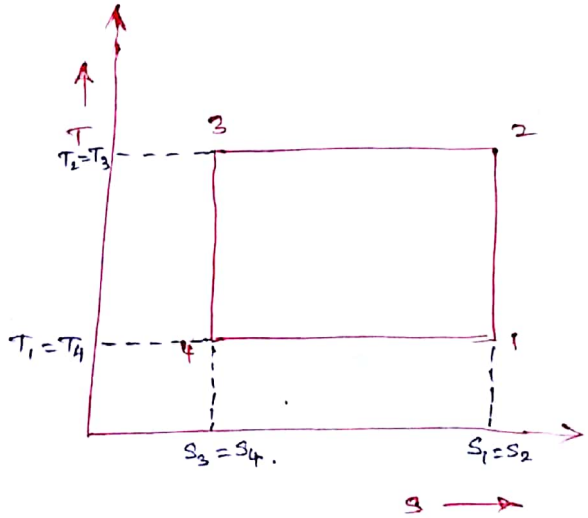
$T_1 = T_L$.

This cycle consist of four reversible processes. Therefore, it is a reversible cycle. By carnot theorem, the reversible engine gives the maximum efficiency than any other engine. Thus, the carnot cycle has maximum efficiency than any other cycle.

Reversed Carnot Cycle :-

This cycle consist of two isothermal and two isentropic process This cycle is used to extract heat from cold body and rejects it into hot body. Therefore the carnot cycle is performed in the reverse direction.





Process. 1-2 = Isentropic compression in a compressor,

2-3 = Constant heat rejection to a hot body.

3-4 = Isentropic expansion in a expansion valve.

4-1 = Constant heat extraction from cold body.

Heat extraction during process 4-1.

$$(E) = Q_s = T_1 ds = T_4 \cdot ds.$$

Heat rejection during process 2-3.

$$Q_R = T_2 ds = T_3 ds.$$

Coefficient of performance, $COP = \frac{\text{Heat extraction.}}{\text{Work input.}}$

$$= \frac{E}{|W|} = \frac{T_1 \, ds}{(T_2 - T_1) \, ds}.$$

$$COP. = \frac{T_1}{T_2 - T_1}$$

Here, $T_1 = T_L$ and $T_2 = T_H$.

$$COP = \frac{T_L}{T_H - T_L}.$$