

## → 2<sup>nd</sup> Law of Thermodynamics

1. Kelvin plank statement:-

This statement say that it is impossible an engine, can have 100% efficiency. because it is impossible complete absorb heat from source is convert into work without giving to sink.

Clarius Statement.

→ This statement state that, ~~it is~~ without any external agency, heat, can not flow cold body, to hot body.

## Heat Engine

→ An engine, which convert heat energy into mechanical energy is known as heat engine.

### Type of heat engine

1. External combustion engine.

In this engine combustion of fuel take place outside the engine.

Eg. Steam engine.

2. Internal combustion engine.

In this engine, combustion of fuel take place inside the engine.

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Ex diesel engine and petrol engine.

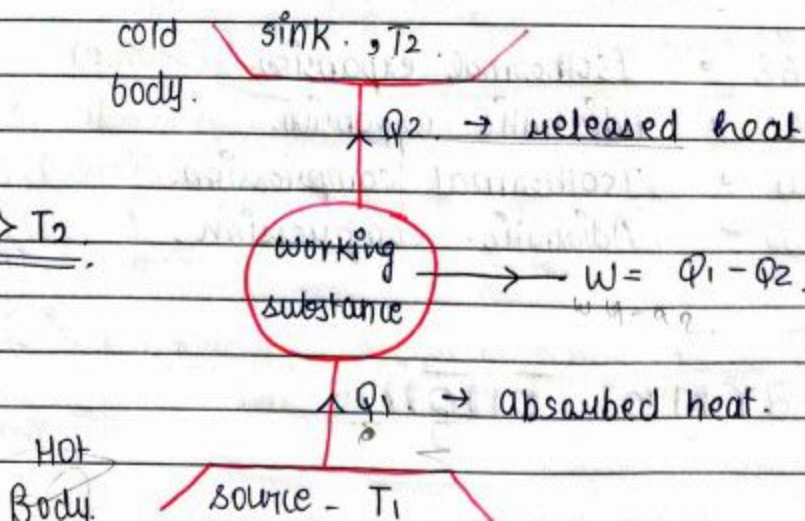


2 stroke

4 stroke

- fuel stroke.
- compression stroke.
- Power stroke.
- exhausting stroke.

$T_1 > T_2$



## Efficiency of heat engine

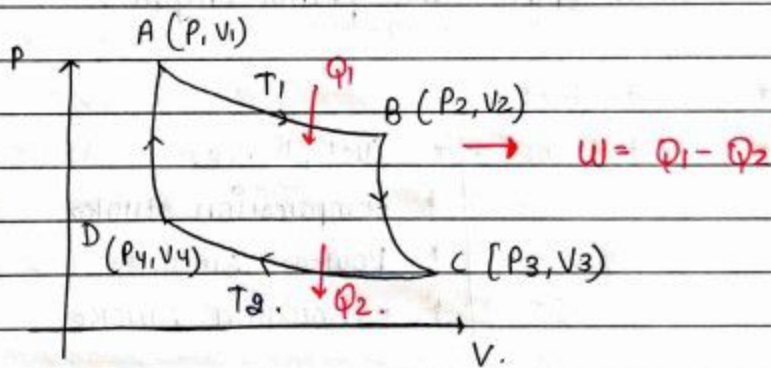
$$\eta = \frac{\text{output}}{\text{Input}} \Rightarrow \eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

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

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

\*\*\* source and sink are high thermal capacity body.

## Carnot Cycle



- AB → Isothermal expansion. (source)
- BC → Adiabatic expansion. (stand)
- CD → Isothermal compression. (sink)
- DA → Adiabatic compression. (stand).

## Carnot Engine

→ It is based on Carnot cycle and it has maximum efficiency.

1. Carnot engine is an ideal engine.
2. In a Carnot engine, four parts:
  - source
  - sink
  - working substance
  - stand
3. In a Carnot engine, ideal gas is used as working substance.
4. Stand is on non-conducting body; it is used in adiabatic process.

Work

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$$W = W_{AB} + W_{BC} + W_{CD} + W_{DA}$$

$$W = nRT_1 \log_e \frac{V_2}{V_1} + \frac{nR(T_1 - T_2)}{\gamma - 1} + nRT_2 \log_e \frac{V_4}{V_3} + \frac{nR(T_2 - T_1)}{\gamma - 1}$$

$$W = nRT_1 \log_e \frac{V_2}{V_1} + \frac{nR(T_1 - T_2)}{\gamma - 1} + nRT_2 \log_e \frac{V_4}{V_3} - \frac{nR(T_1 - T_2)}{\gamma - 1}$$

[In complete Carnot cycle, work done by adiabatic process is 0].

$$W = nRT_1 \log_e \frac{V_2}{V_1} + nRT_2 \log_e \frac{V_4}{V_3}$$

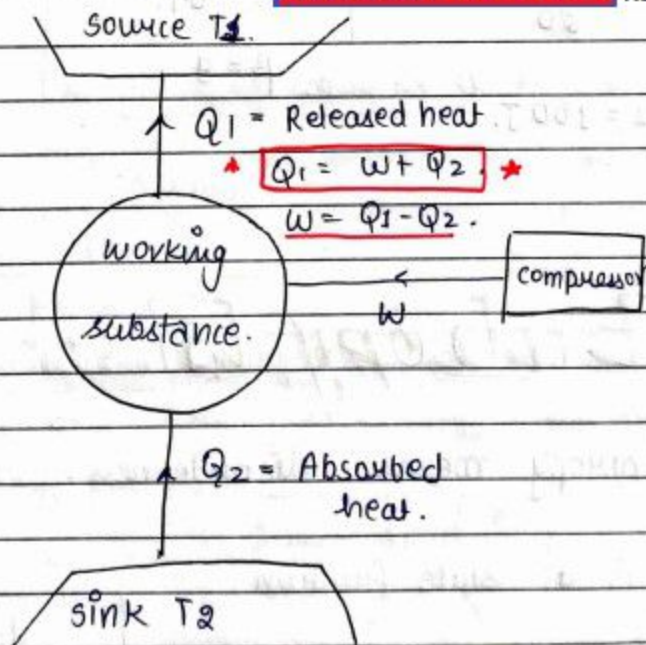


# A.C of Refrigerator

- This instrument is work opposite to Carnot engine.
- In this instrument released heat is always greater than absorbed heat.
- In a close room, if door of Refrigerator is open then Temperature of room is increase.

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Coefficient of performance:-

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2} \quad \left| \quad \frac{Q_2}{Q_1} = \frac{T_2}{T_1} \right.$$

→ A Carnot engine efficiency is  $\eta$  is used as a compressor.

$$\beta = \frac{1-\eta}{\eta}$$

Que A Carnot engine efficiency is 10% is used as a compressor. in a Refrigerator, then work done is 20J, then find out how much heat absorb.

Ans:

$$\beta = \frac{Q_2}{W}$$

$$9 = \frac{Q_2}{20}$$

$$Q_2 = 180 \text{ J}$$

$$\beta = \frac{1-\eta}{\eta}$$

$$\beta = \frac{1-0.1}{0.1}$$

$$\beta = 9$$

$$\beta = \frac{Q_2}{W}$$

$$\Rightarrow \frac{10 \times 100}{100} = \frac{Q_2}{20}$$

$$\beta = \frac{1-0.1}{0.1}$$

$$\Rightarrow 9 = \frac{Q_2}{20} \Rightarrow \frac{180}{10} = \frac{Q_2}{20}$$

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(180)