Date:
Page No.

Q. In a Carnot Cycle the isothermal expansion of an ideal gas takes place at 400K and isothermal compression at 300K. during the expansion 500 cal. of heat transfer to gas

(i) Determine work perform by gas during isothermal expansion

(ii) the heat rejected from gas during isothermal compression

(iii) Work done on Gas during isothermal compression.

Sol. $Q = W = 500$ cal

$= 500$ cal. $= 500 \times 4.2 = 2100$ J.

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

$$\frac{500}{Q_2} = \frac{400}{300}$$

$$Q_2 = \frac{1500}{4} = 375 \text{ cal.}$$

$= \cancel{375 \times 4.2}$

(ii) $W_2 = Q_2 = 375 \times 4.2$ Joule

Q. A reversible engine works between to temp. whose diff. is 100°C. if it takes 746 Joule of heat from the source & gives 546 Joule to sink. Calculate the temp of Source & sink

Date:

Page No.

(1) $T_1 - T_2 = 100$

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2} = \frac{746}{546}$$

$$T_1 = \frac{746}{546} T_2$$

$$\frac{746}{546} T_2 - T_2 = 100$$

$$\left[\frac{746-546}{546}\right] T_2 = 100$$

$$\frac{200}{546} T_2 = 100$$

$$T_2 = \frac{546 \times 1\cancel{00}}{2\cancel{00}}$$

$$T_2 = 273\,K = 0^\circ C$$

$$T_1 = 373\,K = 100^\circ C$$

Q. The efficiency of carnot cycle is 1/6 on reducing the temp. of sink by 65°c the efficiency increase to 1/3 find the initial & final temp. between which the cycle is working

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

$$\frac{1}{6} = 1 - \frac{T_2}{T_1} \longrightarrow (1) \qquad \frac{T_2}{T_1} = \frac{5}{6}$$

$$\frac{1}{3} = 1 - \frac{T_2 - 65}{T_1} \longrightarrow (2)$$

$$\frac{T_2}{T_1} = \frac{5}{6} \quad , \quad \boxed{\cancel{T_2 = \frac{5}{6} T_1}}$$

$$\frac{1}{3} = 1 - \frac{T_2}{T_1} + \frac{65}{T_1}$$

$$\frac{1}{3} = 1 - \frac{5}{6} + \frac{65}{T_1}$$

$$\frac{1}{3} = \frac{1}{6} + \frac{65}{T_1}$$

$$\frac{65}{T_1} = \frac{2-1}{6} = \frac{1}{6}$$

$$T_1 = 65 \times 6$$

$$T_1 = 390\,K = 117^{\circ}C$$

$$T_2 = \frac{5}{\cancel{6}} \times \overset{65}{\cancel{390}}$$

$$T_2 = 325\,K. = 52^{\circ}C$$

Date:
Page No.

Second law of thermodynamics

Carnot's theoram :-

All reversible engine working b/w the same source & sink have same efficiency what ever the working substance & no irreversible engine working b/w same source & sink can be efficient than reversion engine.

$$\boxed{e_{R_1} = e_{R_2} > e_{IR}}$$

Entropy :- Second law of thermo dynamics can't be derived from Ist law as for Ist law it does not matter how the equilibrium has been attained. Bcoz before & after the equilibrium energy of system remain same.

It required another thermo-dynamic parameter to know how the equilibrium has been obtained. or to know what is the dir^n of process take place. this parameter is called Entropy.

Entropy of a system is a mesure of degree of disorder.

If a substance takes in

[Entropy is zero for reversible system and increase in irreversible system. & it's const for universe (in reversible process) and increase for universe in irreversible process]

an amount of heat dQ in a reversible process at a const temp. T. then $\frac{dQ}{dT}$ is called increase in the entropy of the substance.

If temp is not const during the process, we may consider the heat to be taken in or give up in successive small element dQ such that temp. remain approximately const for each element.

$$\boxed{\Delta S = \int_i^f \frac{dQ}{T}}$$

Second law in terms of entropy

"Any natural process that start in one equilibrium state & ends in another equilibrium state, will go in the dir^n that cause the entropy of the [system + surroundings] (universe) to increase."

$$\Delta S \geq 0$$

$$\boxed{dQ \leq T.dS}$$ Mathematical form.

$$\boxed{T.dS = dU + PdV}$$

$$\boxed{(\Delta S)_{system} + (\Delta S)_{surrounding} \geq 0}$$

for Isolated system.

$$(\Delta S)_{iso} \geq 0.$$

Isoandropic Process :- A reversible process during which the entropy of a system remain cont. is called Isoandropic process.

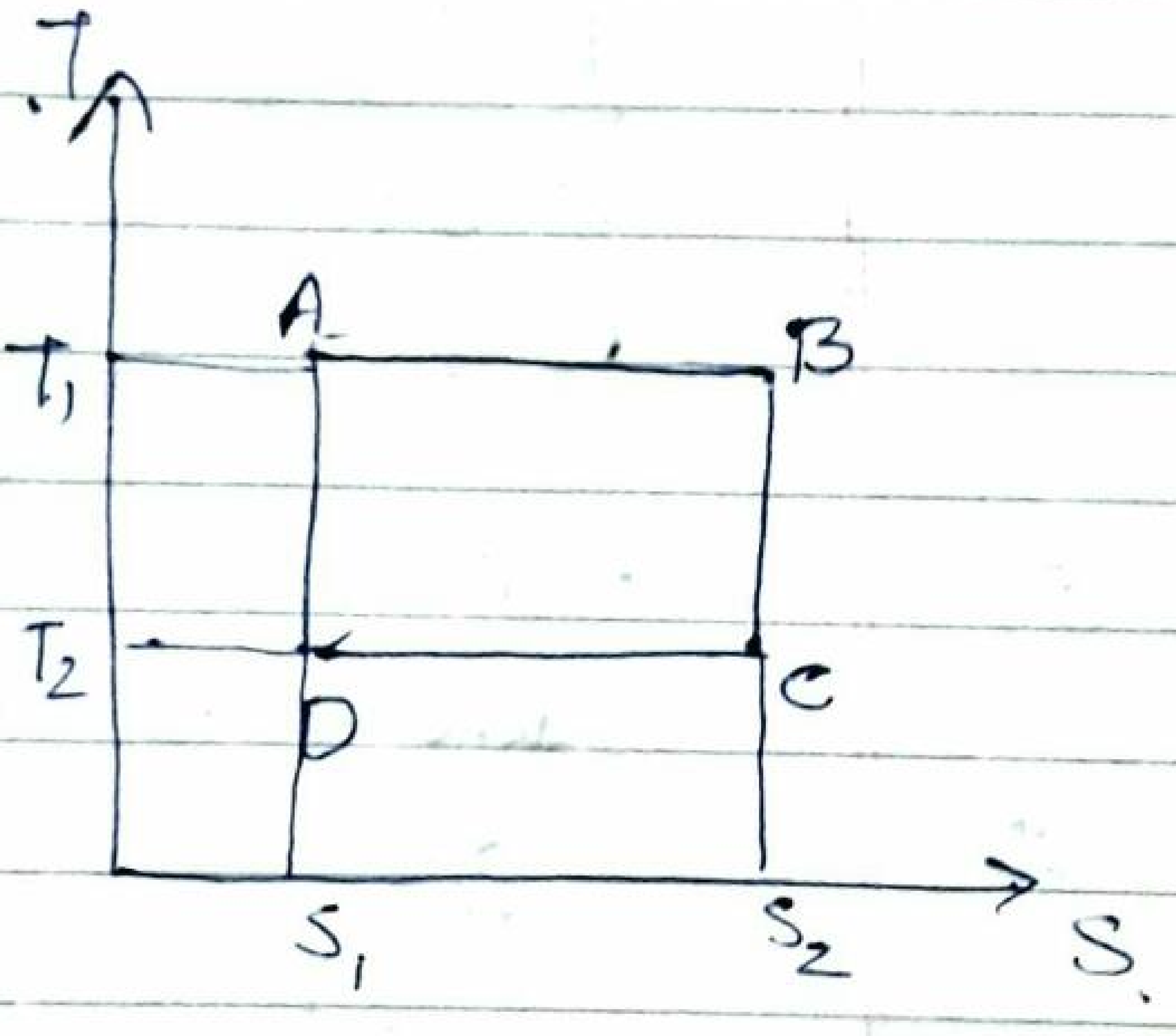
$$dS = 0 \quad \text{or} \quad dQ = 0$$

So Adiabatic is also called Iso andropic.

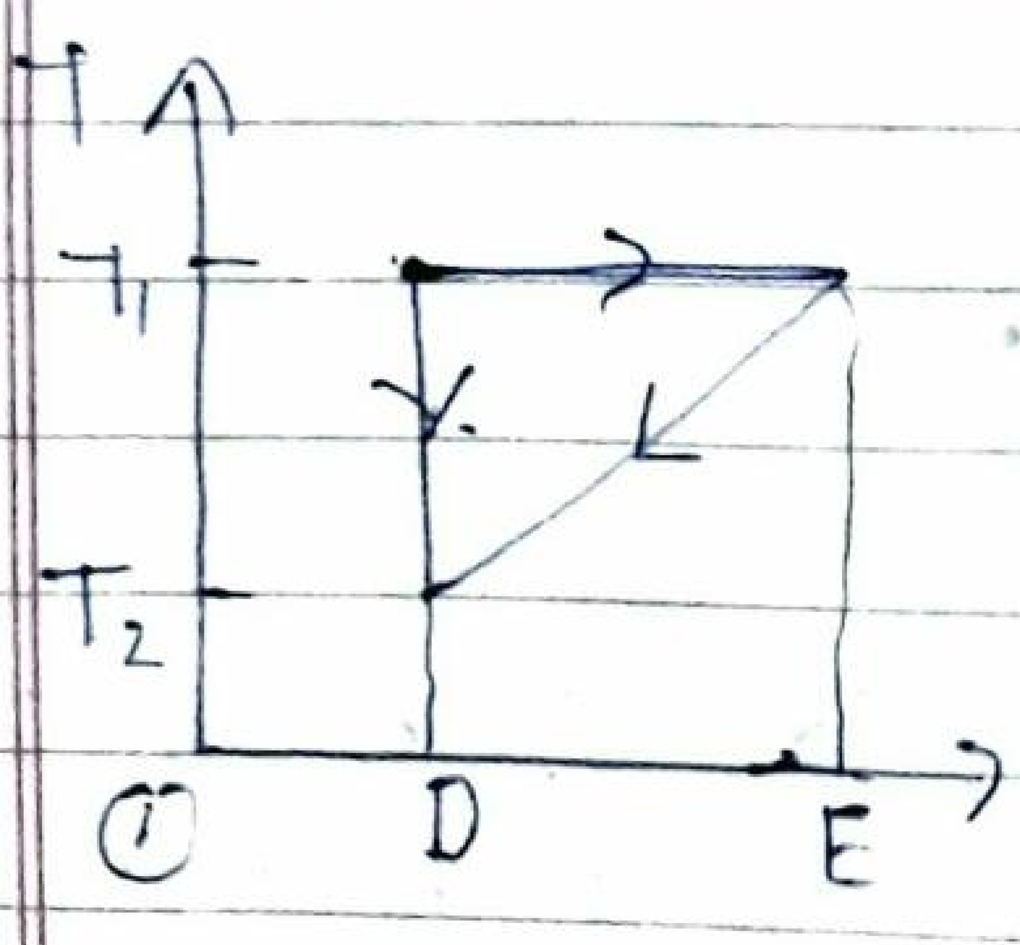
T, S Diagram

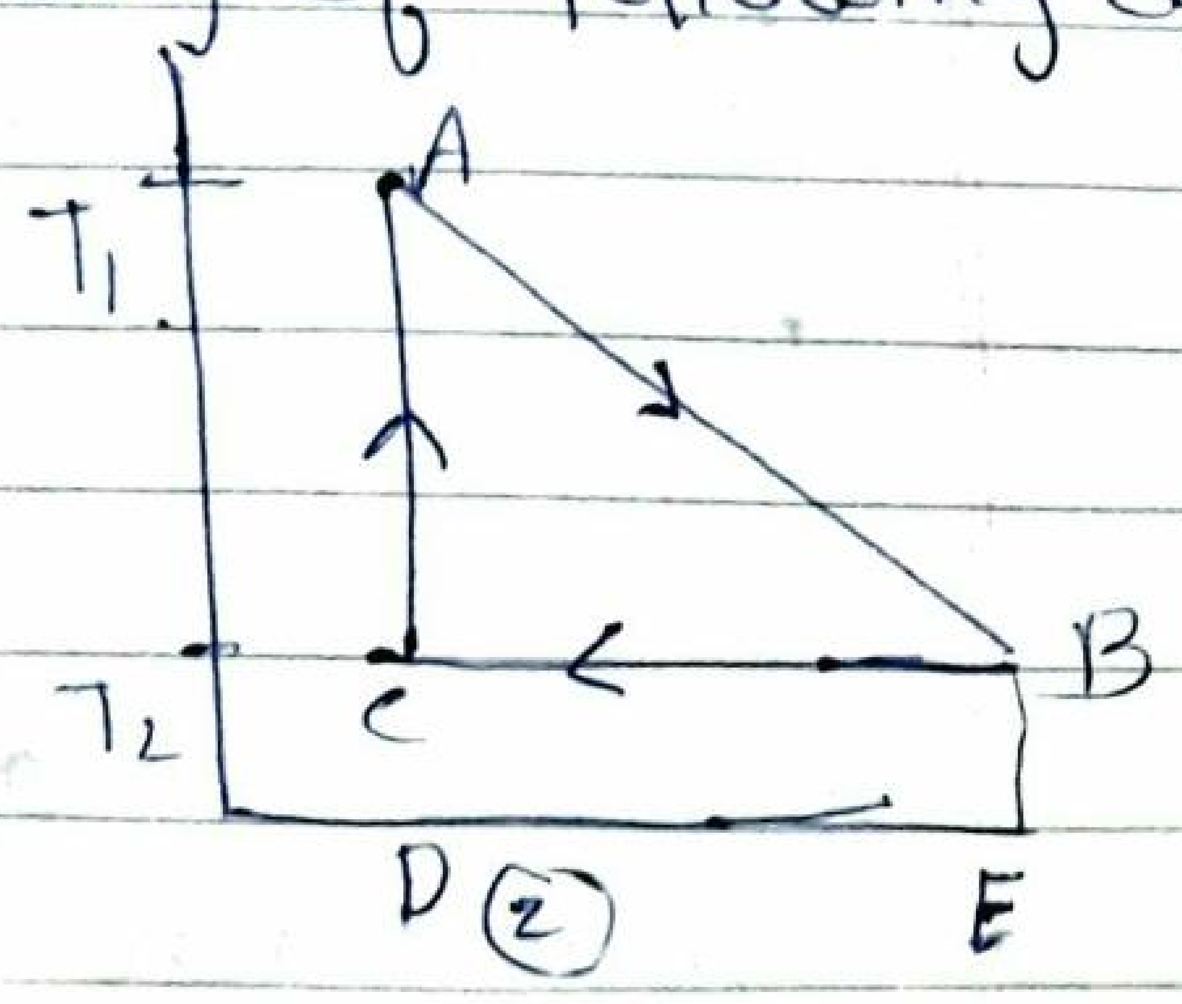
$$\eta = \frac{W}{Q}$$

$$\eta = \frac{\text{Area } ABCD}{\text{Area } ABS_2S_1}$$



compare the efficiency of following cycle.





$$\eta_2 > \eta_1$$

Only for ideal gas
dU=0 for isothermal

Date:
Page No.

Q. Calculate the change in entropy when an ideal gas undergoes ~~reversible~~ isothermal expansion from initial volume V_i to V_f

$$dS = \frac{dQ}{T}$$

$$dQ = 0 + dW = PdV$$

$$= \int_{V_1}^{V_f} PdV = \int_{V_1}^{V_f} \frac{nRT}{V} dV$$

$$dQ = nRT \ln(V_f/V_i) \quad dQ = nRT \ln \frac{V_f}{V_i}$$

$$\cancel{dS = \frac{P}{T}(V_f/V_i)}$$

$$\boxed{dS = nR \ln \frac{V_f}{V_i}}$$ Irreversible

Q. Calculate the change in entropy when a liquid is heated from temp T_1 to T_2

Sol $dS = \frac{dQ}{T}$

$$S = \int_i^f \frac{mc\,dT}{T}$$

$$\boxed{S = mc \ln \frac{T_f}{T_i}}$$

Q. A mass m of liquid at temp T_1 is mixed with and equal mass of same liquid at lower temp T_2. The system is thermally insulated

Calculate the entropy change in process & Show that it is necessary +ve

Sol

$$ds = \frac{dQ}{T}$$

$$\cancel{m}c\,(T_1 - T_f) = \cancel{m}c\,(T_f - T_2)$$

$$T_1 - T_f = T_f - T_2$$

$$2T_f = T_1 + T_2$$

$$T_f = \frac{T_1 + T_2}{2}$$

$$ds = \frac{dQ}{T}$$

$$= \boxed{\cancel{\frac{mc\left[T_1 - \frac{T_1+T_2}{2}\right]}{T_1}}}$$

$$ds = \int_{T_1}^{T} \frac{mc\,dT}{T}$$

$$= mc\left[\ln T\right]_{T_1}^{T_1+T_2/2}$$

$$= mc \ln\left[\frac{T_1+T_2/2}{T_1}\right] = -ve$$

$$ds_2 = \int_{T_2}^{T} \frac{dQ}{T} = \int_{T_2}^{T} \frac{mc\,dT}{T}$$

$$= mc \ln\left[T\right]_{T_2}^{T}$$

$$ds = +ve$$

Date:

Page No.

$$\left(\frac{T_1+T_2}{2}\right) > \sqrt{T_1T_2}$$

$$ds = ds_1 + ds_2$$

$$= mc \ln\left[\frac{T \times T}{T_1 \times T_2}\right]$$

$$ds = 2mc \ln\left[\frac{T}{\sqrt{T_1T_2}}\right]$$

$$\boxed{ds = 2mc \ln\left[\frac{T_1+T_2}{2\sqrt{T_1T_2}}\right]} = +ve$$