THERMODYNAMICS

$$PV^{1/2} = Const$$

$$PV = C$$

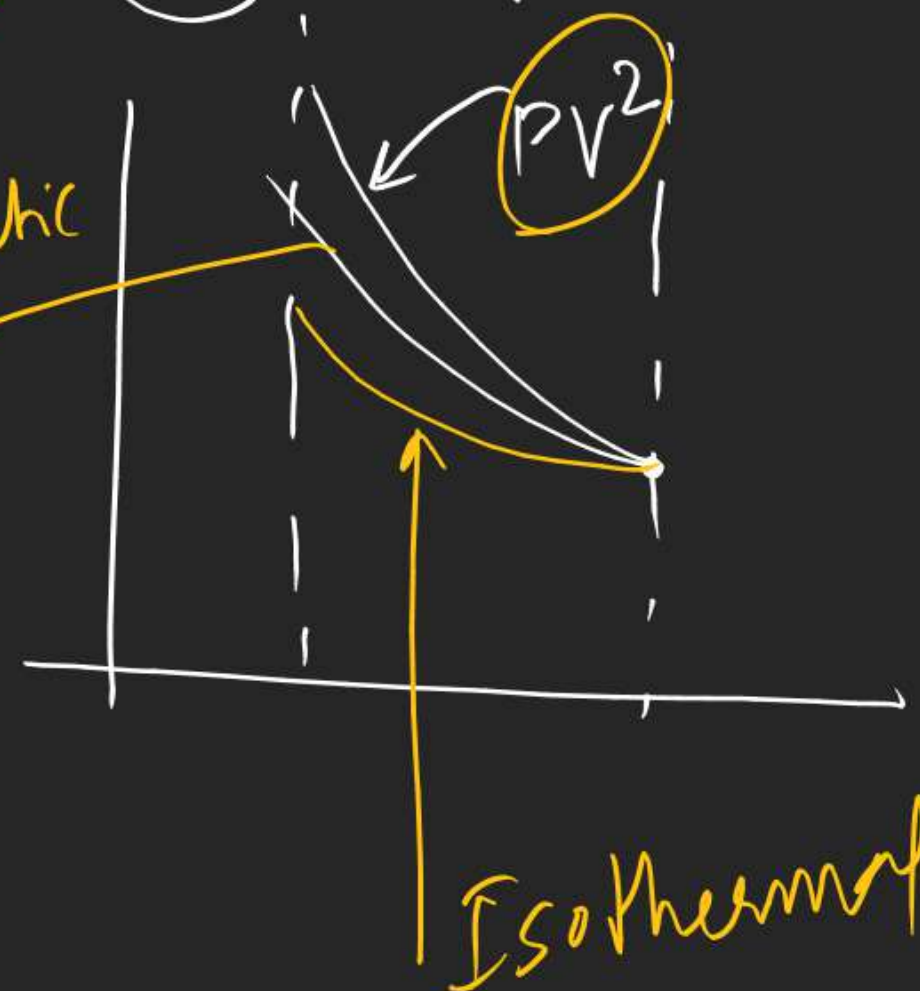$$PV^r = C$$

46

47

i

1 $PV^{1/2}$

2 PV

3

4 PV^r

$PV^{2} = C$

$PV^{r} = C$

PV^{2}

Adiabatic

Isothermal

THERMODYNAMICS

$$\left| W_{rev} \right| > \left| W_{irr} \right|$$

$$W_{rev} < W_{irr}$$

$$T \quad \textcircled{1} \qquad \Delta U_{rev} = \Delta U_{irr} = 0$$
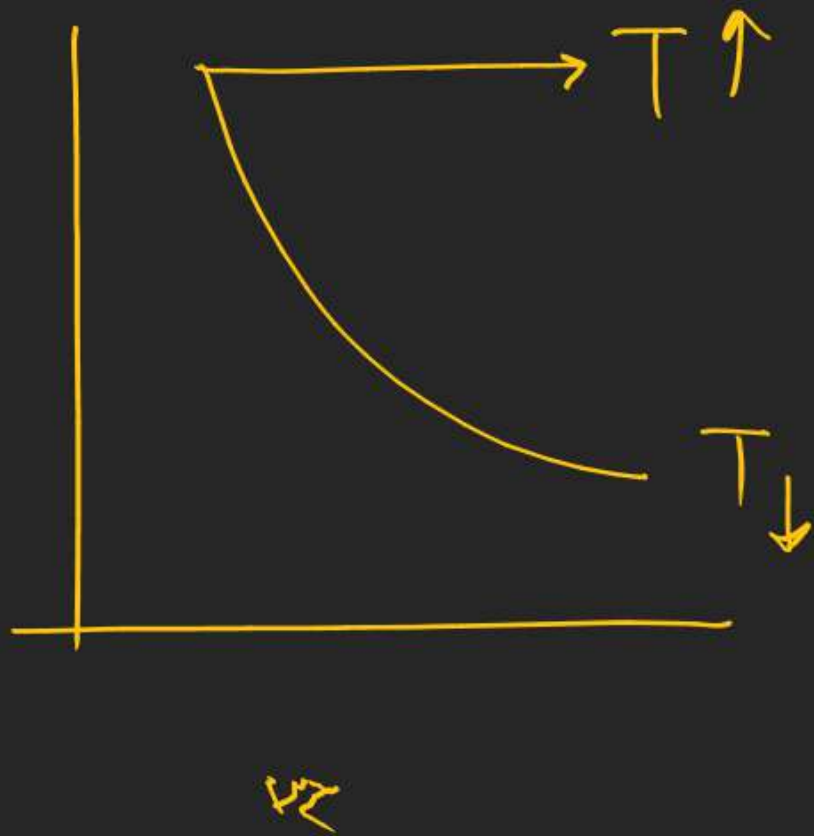
$$\textcircled{8}$$

$$\Delta U_1 + \Delta U_2 = 0$$

$$n_1 \not{C_V} (T - T_1) + n_2 \not{C_V} (T - T_2) = 0$$

$$\frac{P_1 V_1}{T_1} (T - T_1) + \frac{P_2 V_2}{T_2} (T - T_2) = 0$$

THERMODYNAMICS

$$\Delta U_{\text{Isobaric}} > 0$$

$$\Delta U_{\text{Isothermal}} = 0$$

$$\Delta U_{\text{adiabatic}} < 0$$

$$Q = 0$$
$$W = 0$$
$$\Delta U = 0$$

adiabatic free exp
= isothermal

$T \uparrow$

$T \downarrow$

THERMODYNAMICS

$$\eta = \frac{Q_2 + Q_1}{Q_2} \times 100$$

$$\eta = \frac{T_2 - T_1}{T_2} \times 100$$
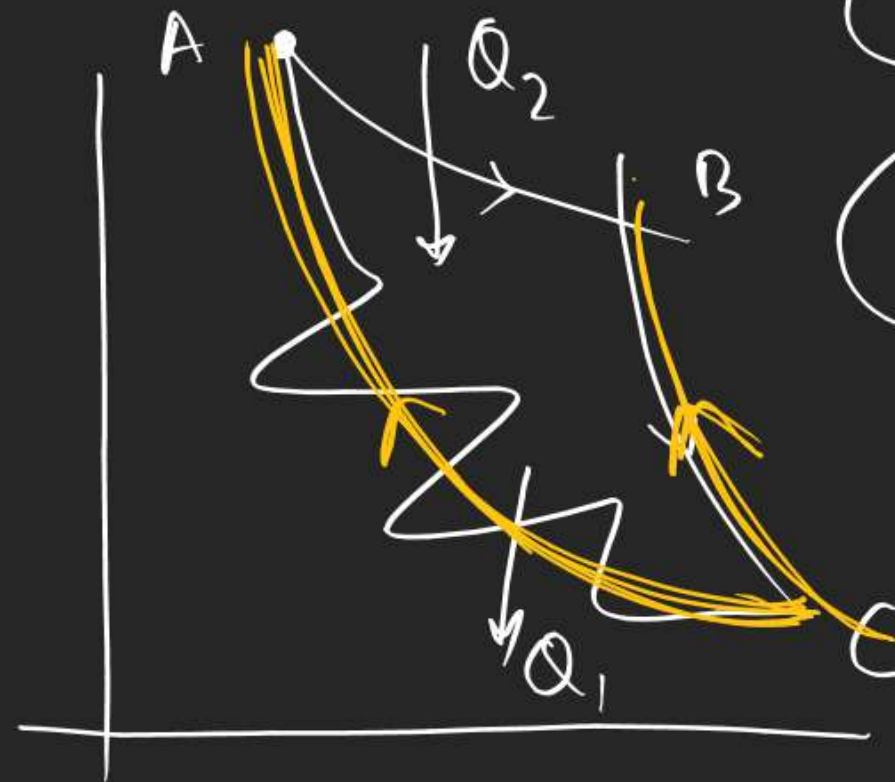
for an engine $\eta \rightarrow 100\%$.
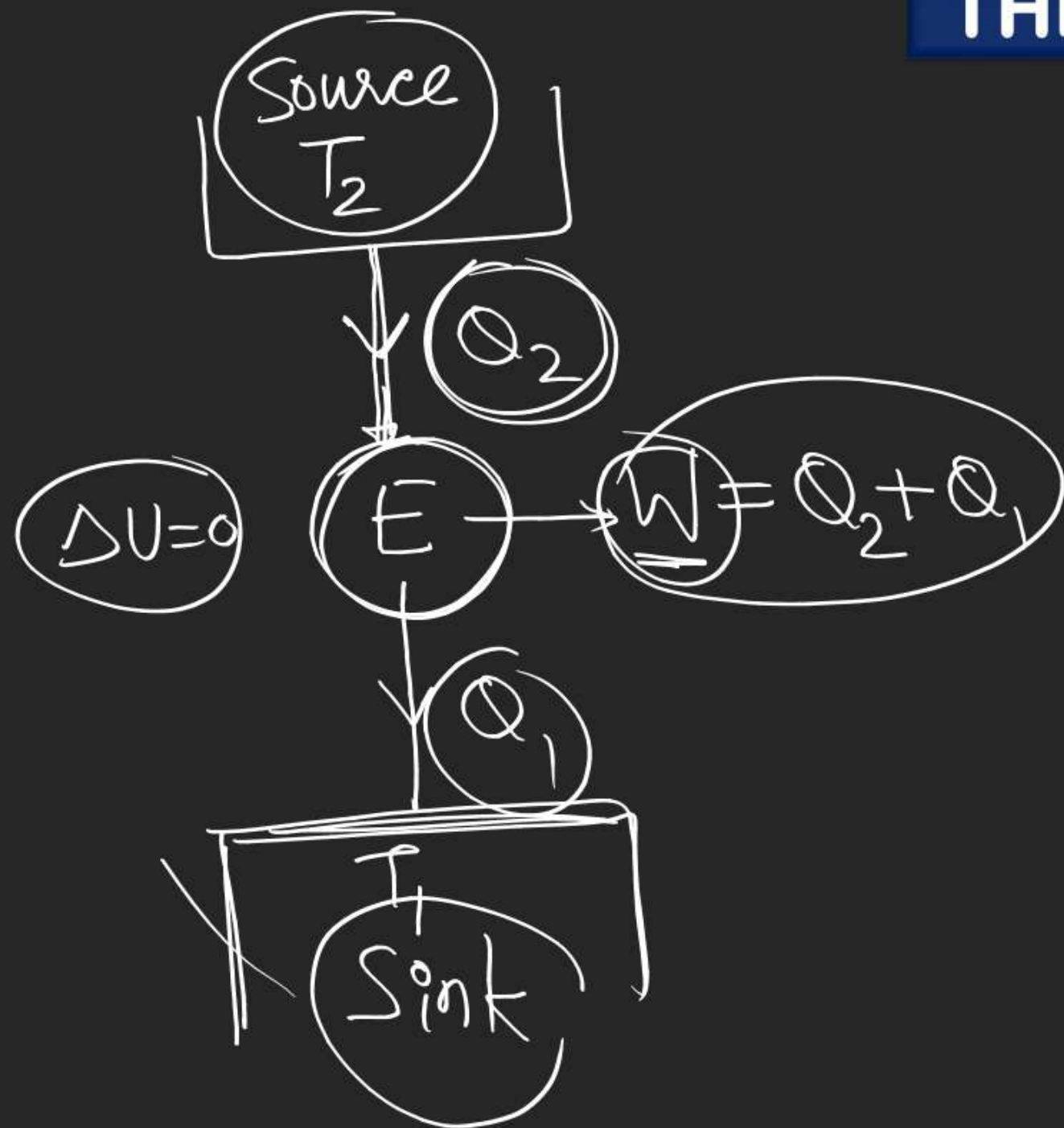
if $T_1 \rightarrow 0K$

or

$T_2 \rightarrow \infty$

2nd Law of T.D.: $\rightarrow$ It is impossible for a cyclic process to convert heat into work without the simultaneous transfer of some part of heat from a body at higher temperature to a body at lower temperature.

THERMODYNAMICS

Source T_2

Q_2

$\Delta U = 0$

E

$W = Q_2 + Q_1$

Q_1

T

Sink

A

Q_2

B

C

Q_1

$Q > 0$

$Q < 0$

THERMODYNAMICS

$$\frac{Q_2 + Q_1}{Q_2} \leqslant \frac{T_2 - T_1}{T_2}$$

isrev

not possible

Rev

$$1 + \frac{Q_1}{Q_2} \leqslant 1 - \frac{T_1}{T_2}$$

$$\frac{Q_1}{T_1} + \frac{Q_2}{T_2} \leqslant 0$$

$$\sum \frac{Q}{T} \leqslant 0$$

Cyclic

$$\oint \frac{q}{T} \leqslant 0$$

for rev cyclic process

$$\oint \frac{q_{rev}}{T} = 0$$

$$\oint ds = 0$$

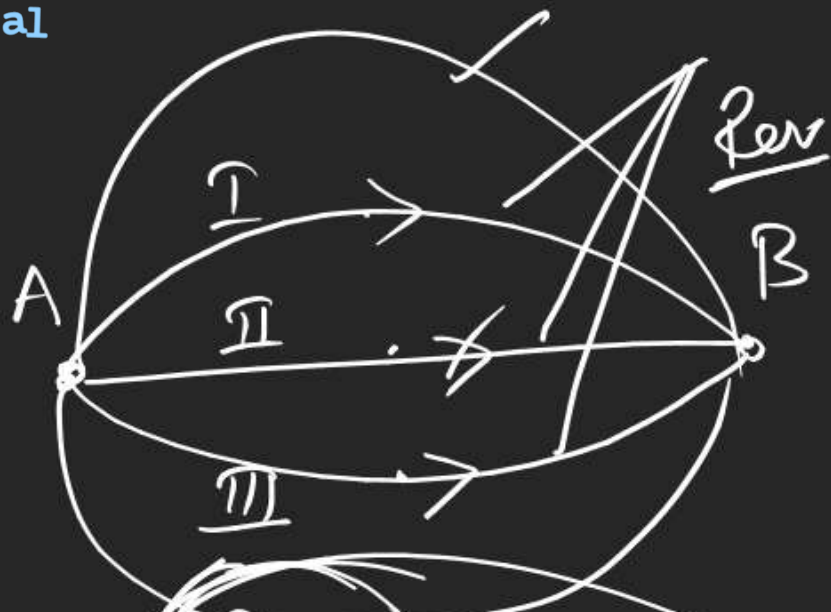$$S = \text{state function}$$

$$\oint d\phi = 0$$

for
irrev cyclic

$$\oint \frac{q_{irr}}{T} < 0$$

$$\oint d\phi < 0$$

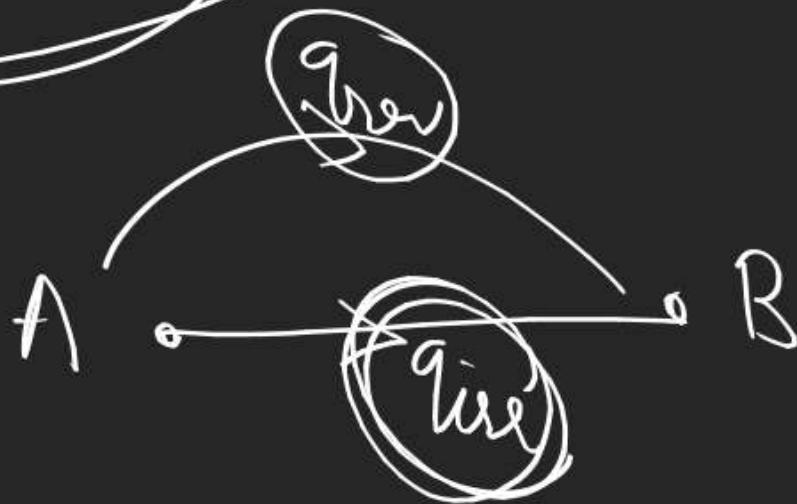$$\phi \neq \text{state function}$$

THERMODYNAMICS

$$\Delta U_I = \Delta U_{II} = \Delta U_{III}$$

$$\left(\frac{q_{rev}}{T}\right)_I = \left(\frac{q_{rev}}{T}\right)_{II} = \left(\frac{q_{rev}}{T}\right)_{III} = dS$$

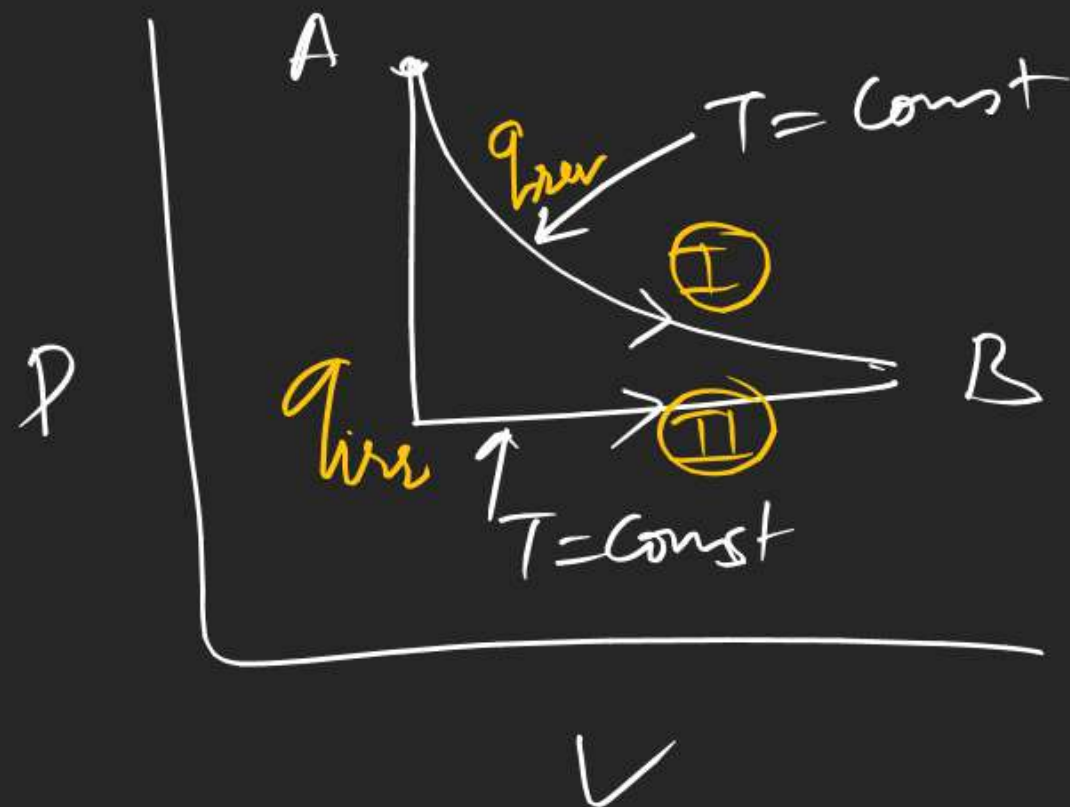$$\frac{q_{rev}}{T} = \text{path independent} = \underline{dS}$$

A ⟶ B

$$\frac{q_{rev}}{T}$$

$$\frac{q_{irr}}{T}$$

$$\Delta U$$
$$\Delta H$$

A ⟶ B

$$q_{rev}$$

$$q_{irr}$$

$$\Delta S_{I} = \Delta S_{II} = \frac{q_{rev}}{T} \neq \frac{q_{irr}}{T}$$

Calculation of ΔS

Case - I for a substance not undergoing any chemical & phase change : $\rightarrow$ @ for ideal gas undergoing any process

$$ds = \int \frac{q_{rev}}{T} = \int \frac{dU - W}{T}$$

$$= \frac{\int nC_v dT + \frac{nRT}{V} dv}{T}$$

$$= nC_v \frac{dT}{T} + \frac{nR \, dv}{V}$$

for a rev. path

$$P_{ext} = P = \frac{nRT}{V}$$

$$W = -P_{ext} dv = -\frac{nRT}{V} dv$$

$$\boxed{\Delta S = nC_v \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}}$$

for rev as well as irrev

$$\boxed{T_1, V_1} \rightarrow \boxed{T_2, V_2}$$
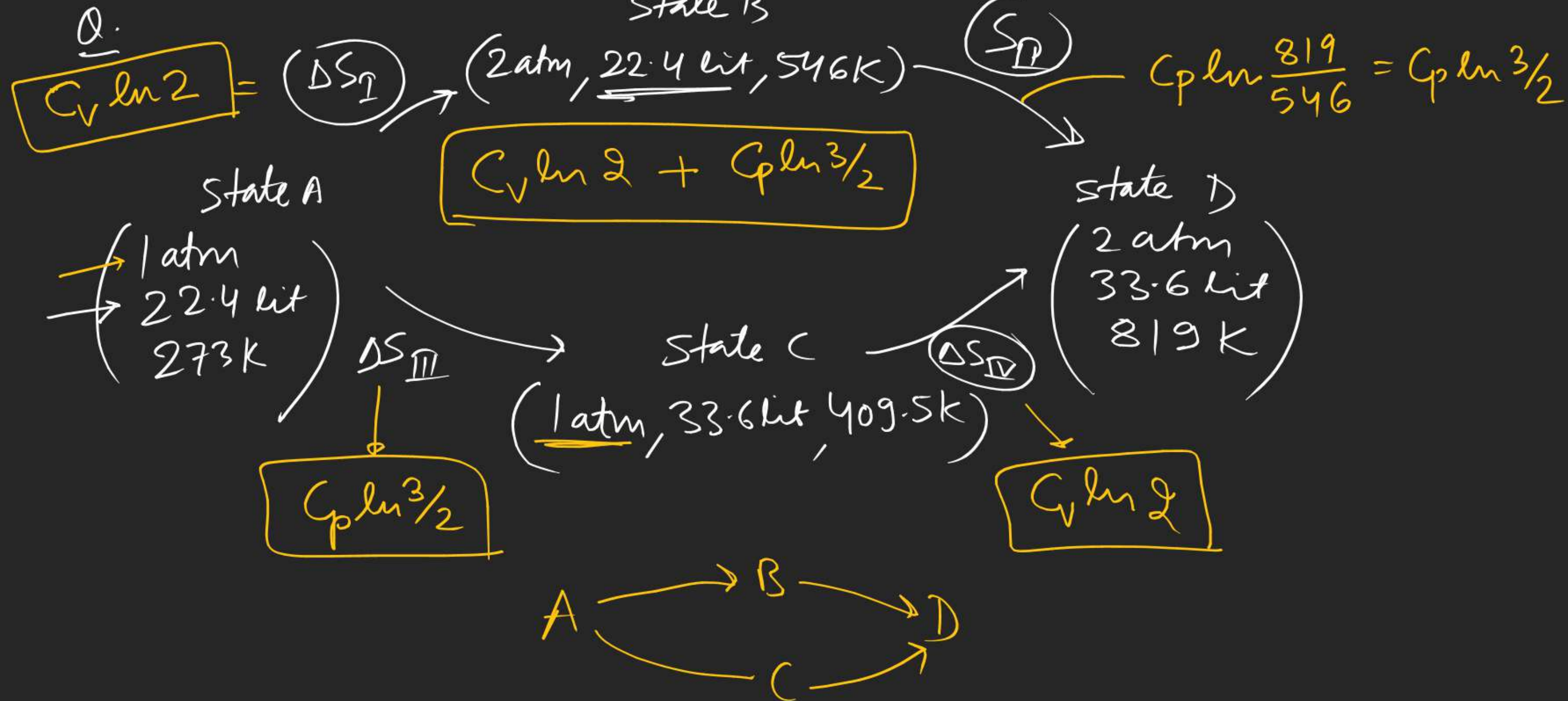
$$\Delta U = n C_v (T_2 - T_1)$$

$$\Delta S = n C_v \ln \frac{T_2}{T_1} + n R \ln \frac{V_2}{V_1}$$

$$= n C_v \ln \frac{T_2}{T_1} + n R \ln \frac{P_1}{P_2} + n R \ln \frac{T_2}{T_1}$$

$$\Delta S = n C_p \ln \frac{T_2}{T_1} + n R \ln \frac{P_1}{P_2}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2} \times \frac{T_2}{T_1}$$

Q.

$$\boxed{C_V \ln 2} = \left(\Delta S_{I}\right) \to \overset{\text{State B}}{\left(2\,atm, \underline{22.4\,lit}, 546K\right)} \to \left(\overset{S_{II}}{}\right) \to C_p \ln \frac{819}{546} = C_p \ln \frac{3}{2}$$

$$\boxed{C_V \ln 2 + C_p \ln \frac{3}{2}}$$

State A

$$\begin{pmatrix} 1\,atm \\ 22.4\,lit \\ 273K \end{pmatrix} \quad \Delta S_{III} \to \overset{\text{State C}}{\left(1\,atm, 33.6\,lit, 409.5k\right)} \to \left(\Delta S_{IV}\right) \to \overset{\text{State D}}{\begin{pmatrix} 2\,atm \\ 33.6\,lit \\ 819\,K \end{pmatrix}}$$

$$\boxed{C_p \ln \frac{3}{2}}$$

$$\boxed{C_V \ln 2}$$

A → B → D

A → C → D

J-Mains

O-II   Remaining