THERMODYNAMICS

(19) $\Delta G = -nRT \ln P_1/P_2$

$= -nRT \ln V_2/V_1$

$= -P_1V_1 \ln V_2/V_1$

(22) $\Delta H_r = $ Ans

$Q = 0$

$W = 0$

$\Delta U = 0$

$\Delta T = 0$

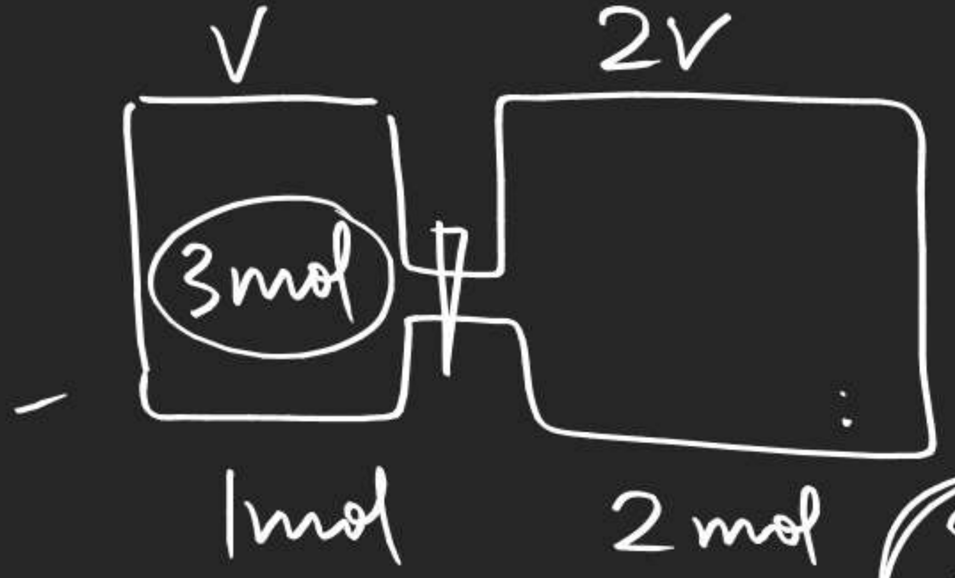
(23) $\Delta S = \frac{-1000}{200}$

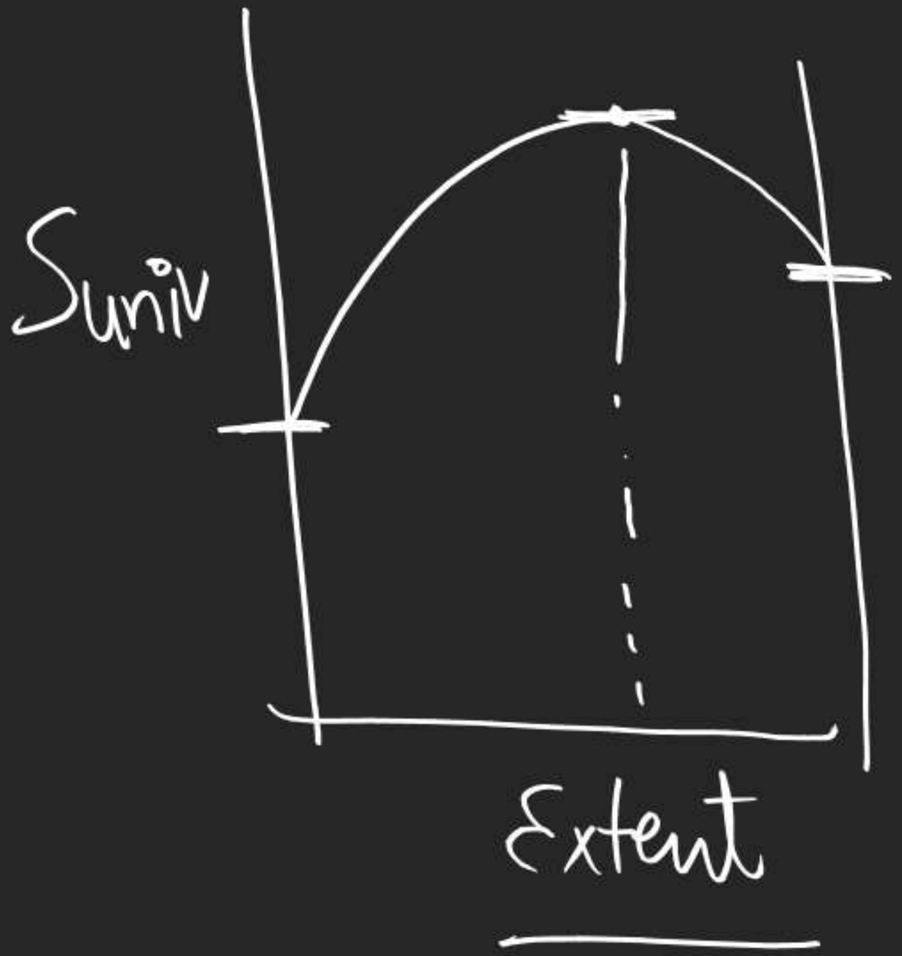
$= -5\ J/K/mol.$

$\Delta G = \Delta H - T\Delta S$

$= -1000 - 150(-5)$

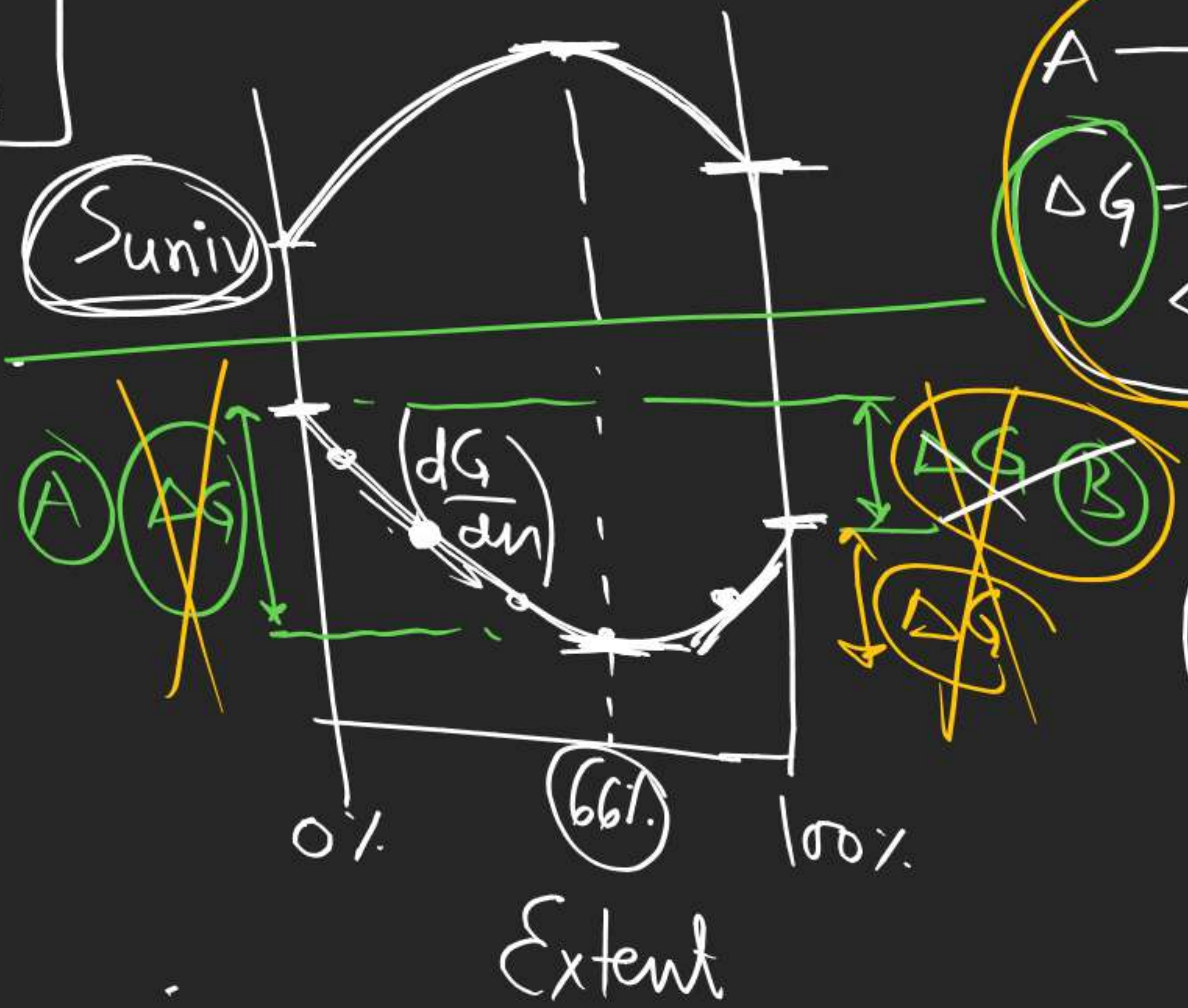
THERMODYNAMICS





$A \longrightarrow B$

$T, P = Const$



$A \longrightarrow B$

$\Delta G = \Delta H - T\Delta S < 0$

$B \longrightarrow A$

$\Delta G > 0$

$$\left(\frac{dG_r}{dn}\right) = \frac{dH_r}{dn} - T\left(\frac{dS_r}{dn}\right)$$

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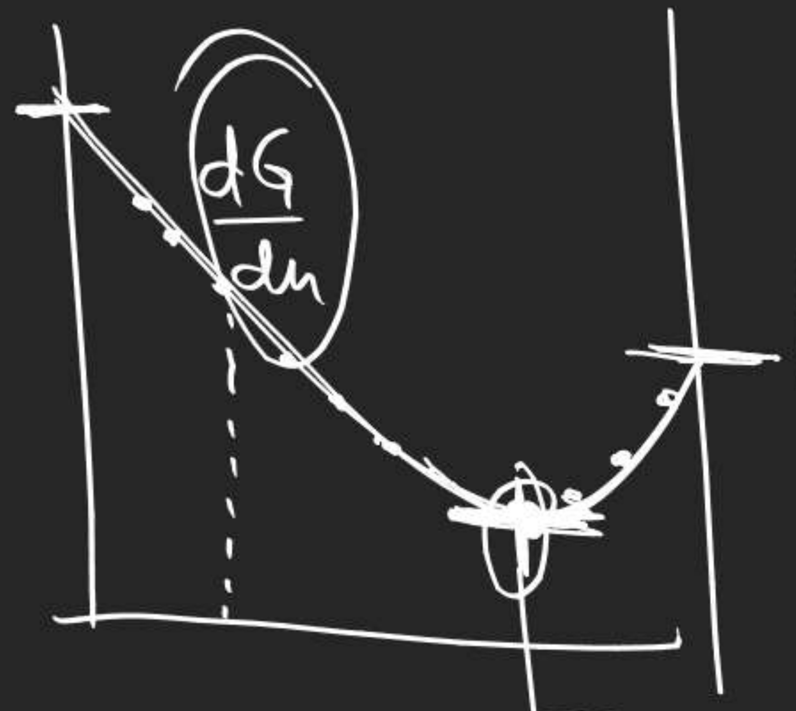
$$A \longrightarrow 2B$$

P_A P_B

$$\Delta G_r = \frac{dG_r}{dx}$$



$$\frac{dG}{dx} = 0$$

At eqlbm $\Delta G_r = 0$

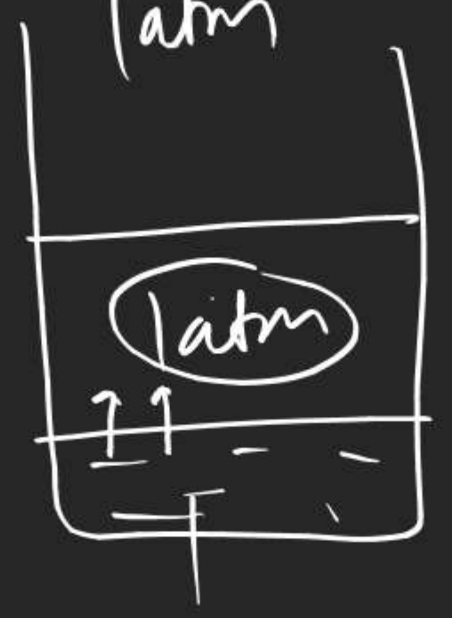
$\Delta H_r \neq 0$

$\Delta S_r \neq 0$

$\Delta S_{univ} = 0$

While maintaining eqlbm

$$\frac{dG}{dx}$$



$$H_2O(l) \rightarrow H_2O(g)$$

$$\boxed{\Delta G_r = 0}$$

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ΔS_r at 10 atm, 300 K

$A_{(g)} \longrightarrow 2B_{(g)} + C_{(g)}$

1 bar   1 bar   1 bar

$-dn$ $2dn$ dn

$(S_{N_2})_{P_2} - (S_{N_2})_{P_1} = R \ln P_1/P_2$

S_{O_2}

S_{NO_2}

$\frac{dH_r}{dn} = \Delta H_r = 50\ kJ/mol$

$\Delta H_r^\circ = 50\ kJ/mol$

$\frac{dH_r}{dn}$

ΔS_r° at 1 atm 300 K

10 atm

$\frac{dS_r}{dn}$

ΔS_r

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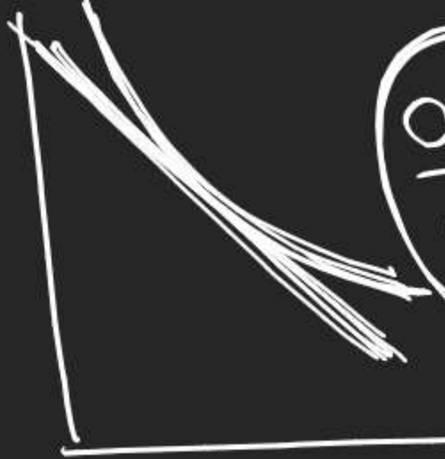
$$A + 2B \longrightarrow C$$

A	2B	C
4 atm	3 atm	1 atm
3 atm	1 atm	2 atm

$$\Delta S_r = S_C - S_A - 2S_B$$



$\frac{dy}{dx}$

$$dn \longrightarrow dS_r$$

$$1 \longrightarrow \frac{dS_r}{dn}$$

$$dx \longrightarrow dy$$

$$1 \longrightarrow \frac{dy}{dx}$$

T

$$A + 2B \longrightarrow C$$

A	2B	C
P_A	P_B	P_C
$-dn$	$-2dn$	dn
S_A	S_B	S_C

$$dS_r = dn\,S_C - dn\,S_A - 2dn\,S_B$$

$$dS_r = dn(S_C - S_A - 2S_B)$$

$$\Delta S_r = \frac{dS_r}{dn} = S_C - S_A - 2S_B$$

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$$A \longrightarrow 2B$$

$$P_A \qquad P_B$$

$$-dn \qquad 2dn$$

$$G_A \qquad G_B$$

$$dG_r = 2dn\,G_B - dn\,G_A$$

$$\frac{dG_r}{dn} = \frac{dG_r^\circ}{dn} + RT\ln Q$$

$$\boxed{\Delta G_r = \Delta G_r^\circ + RT\ln Q}$$

$$\Delta G_r = \Delta G_r^\circ + RT\ln\left(\frac{P_B^2}{P_A}\right)$$

↑ in bar

$$\Delta G = RT\ln P_2/P_1$$

$$G_{P_2} - G_{P_1} = RT\ln P_2/P_1$$

$$(G_B)_{P_B} = (G_B)_{1\,bar} + RT\ln P_B/1\,bar$$

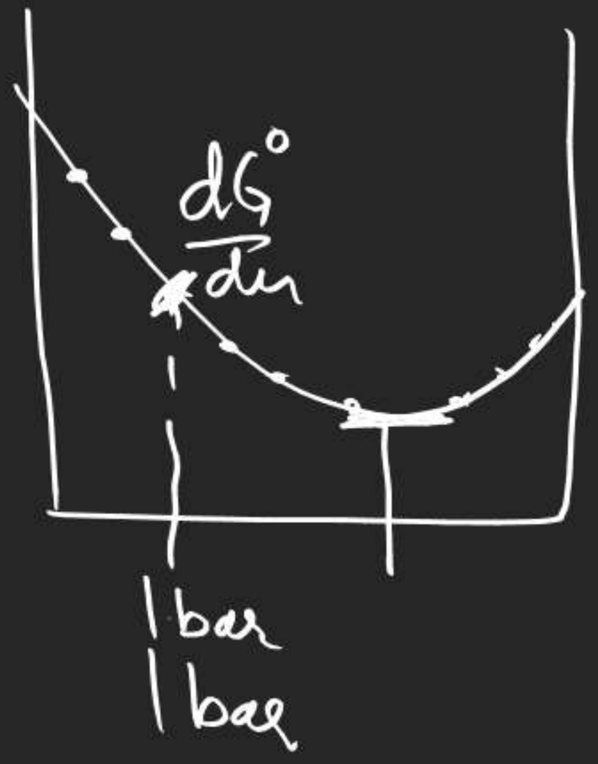
$$2dn\left[(G_B)_{P_B} = G_B^\circ + RT\ln P_B/1\,bar\right.$$

$$dn\left[(G_A)_{P_A} = G_A^\circ + RT\ln P_A/1\,bar\right.$$

$$dG_r = dG_r^\circ + dn\,RT\ln\frac{(P_B/1\,bar)^2}{(P_A/1\,bar)}$$

at eq$^{lb^m}$ $\Delta G_r = 0$

$$\boxed{\Delta G_r^\circ = -RT\ln K_{eq}}$$



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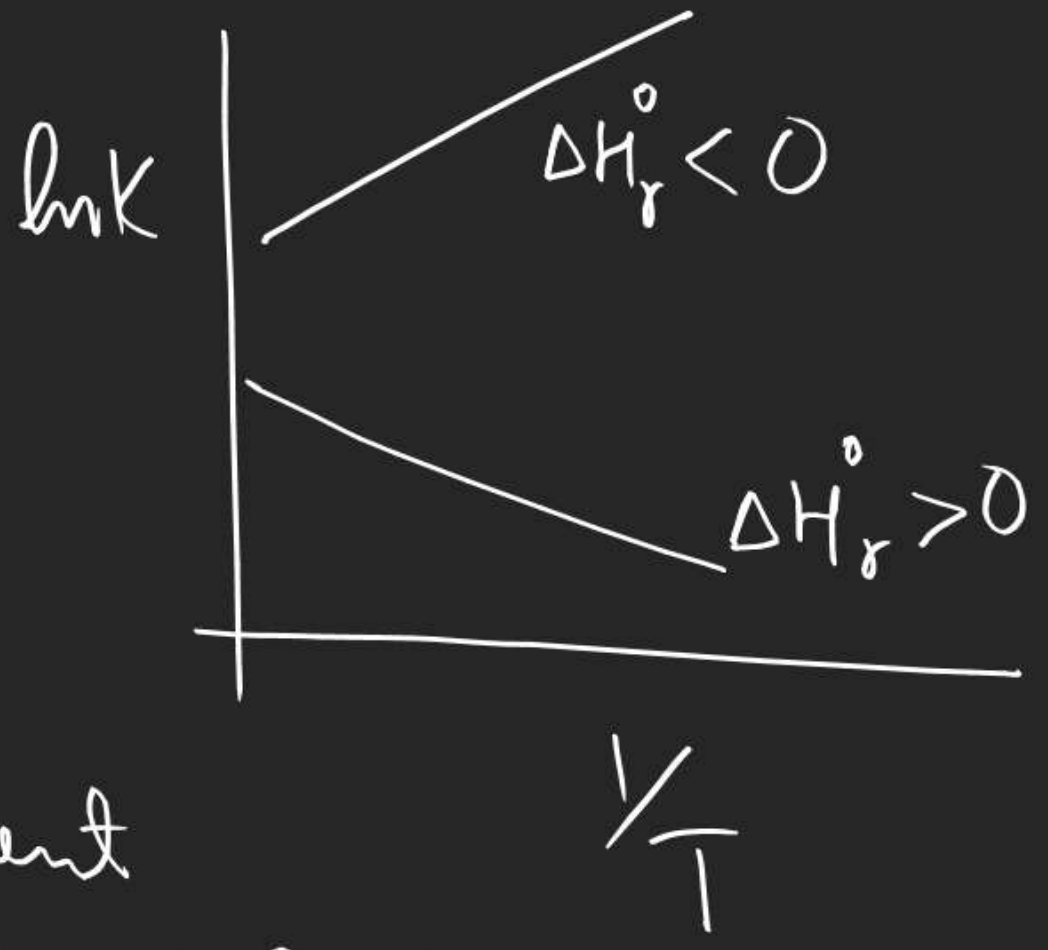
$$\Delta G_r^\circ = -RT\ln K_{eq}$$

$$\Delta H_r^\circ - T\Delta S_r^\circ = -RT\ln K_{eq}$$

$$\ln K_{eq} = \frac{\Delta S_r^\circ}{R} - \frac{\Delta H_r^\circ}{R}\left(\frac{1}{T}\right)$$



Assuming ΔS_r° & ΔH_r° are temp independent

$$\ln K_{T_1} = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{R}\left(\frac{1}{T}\right) \qquad \ln K_{T_2} = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{R}\left(\frac{1}{T_2}\right)$$

Van't Hoff eqn

$$\boxed{\ln\frac{K_{T_2}}{K_{T_1}} = \frac{\Delta H^\circ}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]}$$

THERMODYNAMICS

$S^\circ \leftarrow$ standard condition

for gases $\rightarrow$ 1 bar

for ion/solute $\rightarrow$ 1 M

Temperature is not fixed

$S^\circ_{O_2} = 100\ J/K/mol$ = entropy of O_2 at 1 bar (at 500 K)

S°_{300K} S°_{500K}

S°_{700K}

$\boxed{\Delta H^\circ_r \leftarrow \Delta H_r \text{ at } 1\ bar}$

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THERMODYNAMICS

0 – 2   44 – 49

5 – 2   25 – 31