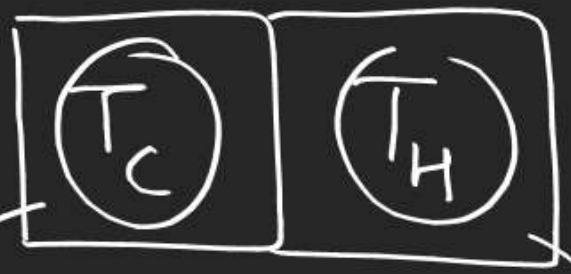
11



$$T_f = \frac{T_C + T_H}{2}$$

$$\Delta S_{I} = C \ln \frac{\left(\frac{T_C + T_H}{2}\right)}{T_C}$$

ΔS_{II}

12

13

$$A(l) \longrightarrow A(g)$$

$$\Delta H = 60\ kJ/mol$$

$$\Delta S_{sys} = \frac{60 \times 10^3}{300}$$

$$\Delta S_{univ} = 0$$

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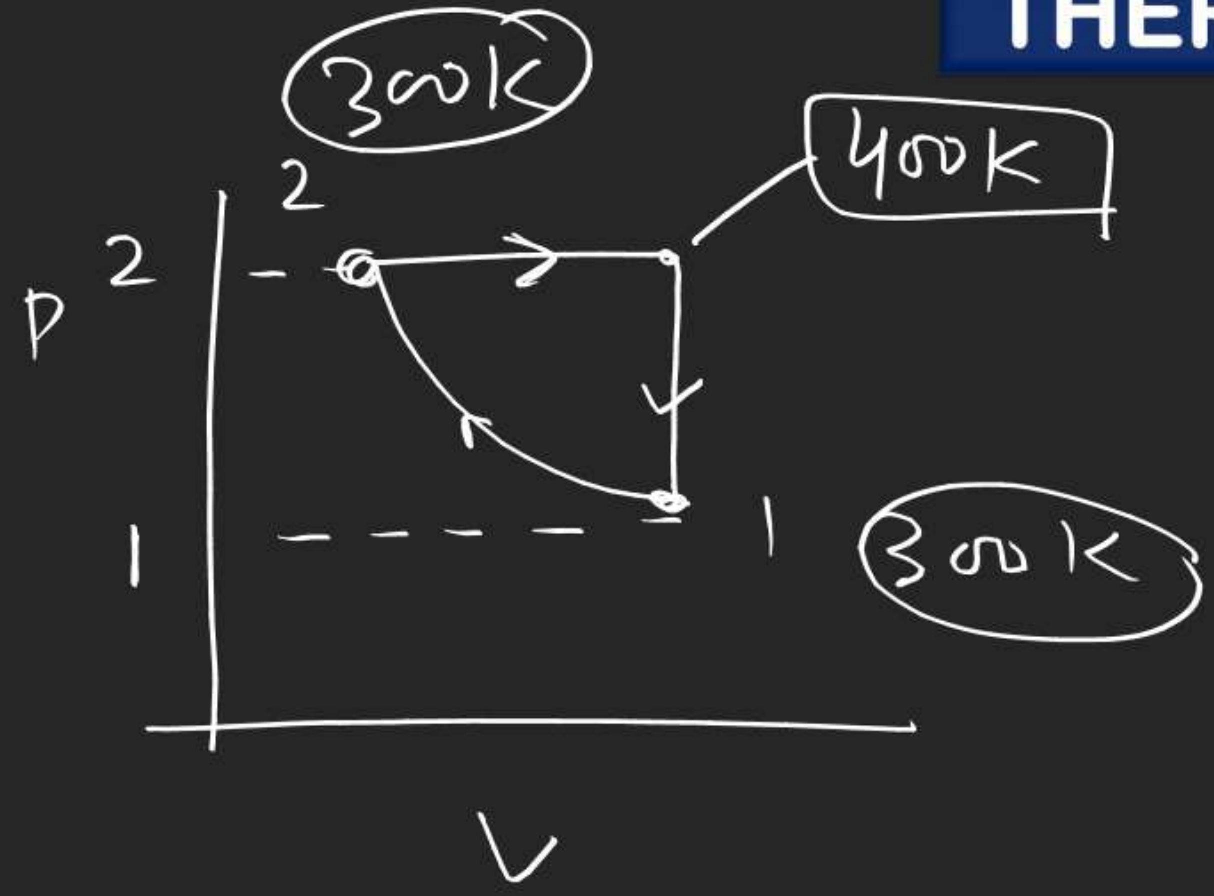
21

$$\Delta S_r = S(Pr) - S(R)$$

$$-266 = 87 \times 6 - 4x - 205$$

9



10

$$\Delta S = \int_{300}^{600} \left(10 + 10^{-2} T\right) \frac{dT}{T}$$

$$= 10 \ln \frac{T_2}{T_1} + 10^{-2}\left(T_2 - T_1\right)$$

THERMODYNAMICS

11

$$\boxed{400K} \xrightarrow{100\,kJ} \boxed{300K}$$

$Q = -100\,kJ$

$Q = +100\,kJ$

$$\Delta S = \frac{-100 \times 10^3}{400}$$

$$\Delta S = \frac{100 \times 10^3}{300}$$

16

$\Delta H = 75\,kJ$

$= Q_{sys}$

$Q_{surr} = -75\,kJ$

$$\underline{\Delta S_{surr}} = \frac{Q_{surr}}{300}$$

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THERMODYNAMICS

$$\boxed{(\Delta S_r)_{T_2} - (\Delta S_r)_{T_1} = (\Delta C_p)_r \ln T_2/T_1}$$

$\Rightarrow$ Variation of (ΔS_r) with Pressure at const 'T'

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

$$S_{P_2} - S_{P_1} = R \ln P_1/P_2$$

$$\rightarrow c \times [(S_c)_{P_2} - (S_c)_{P_1} = R \ln P_1/P_2$$

$$a \times [(S_A)_{P_2}$$

$$b \times [(S_B)_{P_2}$$

$$(\Delta S_r)_{P_2} - (\Delta S_r)_{P_1} = (c-a-b) R \ln P_1/P_2$$

$$(\Delta S_r)_{P_2} - (\Delta S_r)_{P_1} = \Delta n_g R \ln P_1/P_2$$

THERMODYNAMICS

$$aA + bB \longrightarrow cC \qquad (\Delta H_r)_{T_1} \qquad (\Delta H_r)_{T_2} = ?$$

$$H_{T_2} - H_{T_1} = C_p\, dT + \cancel{\left(\frac{\partial H}{\partial P}\right)_T dP}$$

$$\boxed{(\Delta H_r)_{P_2} \simeq (\Delta H_r)_{P_1}}$$

$$\boxed{(\Delta H_r)_{T_2} - (\Delta H_r)_{T_1} = (\Delta C_p)_r (T_2 - T_1)}$$

Kirchhoff eqn

$$\boxed{(\Delta U_r)_{T_2} - (\Delta U_r)_{T_1} = (\Delta C_V)_r (T_2 - T_1)}$$

Q. for the rxn

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\quad \Delta H_r = 50$ kJ/mol at 1atm 300K

$\Delta C_{p_r} = 2\times25 - 20 - 2\times20$
$= 50 - 60 = -10$

$S_{N_2}(g) = 100$ J/mol/K
$S_{O_2}(g) = 125$ ''
$S_{NO_2}(g) = 150$ ''
at 1atm 300K

$C_p(N_2) = C_p(O_2) = 20$ J/K/mol
$C_p(NO_2) = 25$ J/mol/K

find

(i) ΔS_r at 1atm 300K $\;-50$
(ii) '' '' 1atm 600K
(iii) '' '' 10atm 300K
(iv) '' '' 10 atm 600K

(5) ΔH_r at 1atm 600K
(6) '' '' 10atm 300K
(7) '' '' 10atm 600K

(8) ΔS_{surr} at 1atm 300K $= \frac{-50\times10^3}{300}$
(9) '' 1atm, 600K $\;\frac{-47\times10^3}{600}$
(10) '' 10atm, 300K $\;\frac{-50\times10^3}{300}$
(11) '' 10atm 600K $\;\frac{-47\times10^3}{600}$

(ii)

$(\Delta S_r)_{600} = (\Delta S_r)_{300} + (\Delta C_p)_r \ln T_2/T_1$

$= -50 - 10\ln 600/300$

$= -50 - 10\ln 2$

(iii)

$(\Delta S_r)_{10atm} = -50 + (-1)R\ln 1/10$

$= -50 + R\ln 10$

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$$(\Delta S_r)_{T_2,P_2} - (\Delta S_r)_{T_1,P_1} = (\Delta C_p)_r \ln T_2/T_1 + \Delta n_g R \ln P_1/P_2$$

(5)

$$(\Delta H_r)_{600} = 50\text{ kJ} + \frac{(-10)(600-300)}{1000}$$

$= 0$

$$= 50\text{ kJ} - 3\text{ kJ}$$

$$= 47\text{ kJ}$$

(6)

$$(\Delta H_r)_{10atm} = (\Delta H_r)_{1atm} = 50\text{ kJ}$$

(7)

$$\Delta H_r = 47\text{ kJ}$$

(iv)

$-50 - 10\ln 2$

$+ R\ln 10$

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THERMODYNAMICS

Gibb's energy (G)

It is a state function

$$G = H - TS$$

$$G = U + PV - TS$$

for a change

$$dG = dU + PdV + Vdp - TdS - SdT$$

$$dG = q + \cancel{W_{PV}} + W_{non\text{-}PV} + \cancel{PdV} + Vdp - TdS - SdT$$

at const T, P and in the absence of non-PV work

$$W = -P_{ext}dV = -PdV$$

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THERMODYNAMICS

$$dG_{sys} = q_{sys} - T_{sys}\, dS_{sys}$$

$$dS_{surr} = -\frac{q_{sys}}{T_{sys}}$$

$$q_{sys} = -T_{sys}\, dS_{surr}$$

$$dG_{sys} = -T_{sys}\left(dS_{surr} + dS_{sys}\right)$$

$$\boxed{dG_{sys} = -T_{sys}\, dS_{univ}}$$

$(dG_{sys})_{T,P} < 0$ feasible

$(dG_{sys})_{T,P} > 0$ not feasible

$(dG_{sys})_{T,P} = 0$ Reversible

n T, P V

ΔG

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0-I	22-24
5-I	17-18