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Analytical Problem

1. $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings} = \frac{Q}{T} - \frac{Q}{T} = 0$

2. A. For cycle $\Delta U = 0$, $\Delta H = 0$, $\Delta S = 0$

b. This step occurs during the adiabatic compression step $= nRT\ln\left(\frac{V_a}{V_d}\right) = 0$

C. $T_{hot} V_b^{\gamma-1} = T_{cold} V_c^{\gamma-1}$ and $T_{cold} V_d^{\gamma-1} = T_{hot} V_a^{\gamma-1}$

$-nRT\ln\left(\frac{V_b}{V_a}\right)$ total work is positive $W = \int_a^b p(V)\,dV$

d. efficiency = (net work done by gas / heat absorbed by gas)

$(W_a + W_b - W_c - W_d) / Q$

3. A. $dS = \left(\frac{dS}{dP}\right) dP + \left(\frac{dS}{dT}\right)_P dT$

$\left(\frac{dS}{dP}\right)_T = -\left(\frac{dV}{dT}\right)_P = -Br$ $\quad \left(\frac{dS}{dT}\right)_P = \frac{C_P}{T}$

B. $dS = \frac{C_P}{T} dT - Br\, dP$

$\Delta S = \int_{T_1}^{T_2} \frac{C_P}{T} dT - \int_{P_1}^{P_2} Br\, dP$

Numerical Problem

1. $\Delta H^\circ_{rxn} = -1364 - 278 - 394 - (-1273)$

$= -763$ KJ/mol

$\Delta S^\circ_{rxn} = 192 + 161 + 213 - 209$

$= 357$ J/(mol·K)

$\Delta G^\circ_{rxn} = -869439.55$ J/mol $= -86.94$ KJ/mol

$\Delta G^\circ_{rxn} < 0$ reaction is spontaneous

2. $dH = C_P dP$

$\int_1^2 dH = \int_{T_1}^{T_2} C_P dP = \int^{351.3} 65.6 + 2.38 \times 10^{-4}\, T\, dP$

$H_2 - H_1 = 65.6\,[T]_{300}^{\cancel{391.3}\,360} + 2.38 \times 10^{-4}\,[T^2]_{300}^{351.3}$

$H = 45$ KJ mol^{-1}

$\Delta S_{vap} = \Delta H_{vap} / T_b$

42.3 KJ mol $/ 357.3 = 0.1204$ KJ mol^{-1}K^{-1}

3. $\Delta H = T\Delta S$

$$\Delta S_{70-150} = [(\Delta H)_2 / T_2] - [(\Delta H)/T_1]$$

$$(4450/54.39) - (6815/90.2)$$

$$= 81.81 - 75.55 = 6.26.0 \ JK^{-1}$$

The process is Spontaneous