1. a) $T_1 = 293.15\ K$

$P_1 = 4.0\ bar = P_2$

$Q_{1\to2} = 5466\ J = \Delta H = \int n C_p\, dT$

$= 1 \times 3.5 \times 8.314 \times (T_2 - 293.15)$

$T_2 = 480.99\ K$

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b) $Q_{3\to4} = -4100\ J = \Delta U = \int n C_v\, dT$

$= 1 \times 2.5 \times 8.314 \times (197.27 - T_3)$

$T_4 = 197.27\ K$

$T_3 = 394.53\ K$

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$2 \to 3$ adiab. rev. $\qquad \gamma = C_p/C_v = 1.4$

$P_2 V_2^{1.4} = P_3 V_3^{1.4}$

$V_2 = \dfrac{nRT_2}{P_2} = \dfrac{1 \times 0.08314 \times 480.99}{4.0} =$

$= 10.00\ dm^3$

$4.0 \times 10.00^{1.4} = \dfrac{nRT_3}{V_3} V_3^{1.4} = 1 \times 0.08314 \times 394.53 \times V_3^{0.4}$

$V_3 = 16.41\ dm^3 = V_4$

c) $w_{4\to1} = \Delta U_{4\to1} = \int n C_V\, dT =$

($w_{4\to1} = \Delta U_{4\to1}$ because $Q = 0$)

$= 1 \times 2.5 \times 8.314 \times (293.15 - 197.27)$

$= 1993\ J$

d) $\Delta S_{uz,1\to4\to3} = -\Delta S_{1\to3} =$

($\Delta S_{uz,1\to4\to3} = -\Delta S_{1\to3}$ because the process is reversible)

$$= -\left[\int \frac{n C_p}{T} dT + nR \ln \frac{P_1}{P_3}\right] =$$

$$= -\left[1 \times 3.5 \times 8.314 \times \ln \frac{394.53}{293.15} + 1 \times 8.314 \times \ln \frac{4.0}{2.0}\right] = -14.4\ JK^{-1}$$

$$P_3 = \frac{nRT_3}{V_3} = \frac{1 \times 0.08314 \times 394.53}{16.41} = 2.00\ bar$$

e) $w_{4\to5} = -3986\ J = -nRT \ln \frac{V_5}{V_4} =$

$$= -1 \times 8.314 \times 197.27 \times \ln \frac{V_5}{16.41}$$

$V_5 = 1.44\ dm^3$

2.a) $n = \frac{200}{114.23} = 1.751$ mol

$V_{liq} = \frac{200}{0.703} = 284.5\ cm^3$

$\Delta H_1 = 0$ (gperfeito)

$\Delta H_2 = -1.751 \times 41430 = -72538$ J (condensação)

$\Delta H_3 = \int V(1-\alpha_p T)\,dp = V(1-\alpha_p T)\Delta P$

$= 284.5 \times 10^{-6} \times (1 - 1.4 \times 10^{-3} \times 398.75) \times$

$\times (100 - 1.01) \times 10^5 = 1244$ J (no líquido)

$\Delta H = 0 - 72538 + 1244 =$

$= -71294$ J

$\Delta G_1 = \int V\,dp = \int \frac{nRT}{P}\,dp =$

$= nRT \ln \frac{P_f}{P_i} = 1.751 \times 8.314 \times 398.75 \times$

$\times \ln \frac{1.01}{0.5} = 4082$ J

$\Delta G_2 = 0$

$n = \frac{200}{114.23} = 1.751$ mol

$$\Delta G_3 = \int V\,dp \underset{\text{ideal cond.}}{=} V\int dp = V\Delta P =$$

$$= 284.5\times10^{-6}\times(100-1.01)\times10^5 =$$

$$= 2816\ \text{J}$$

$$\Delta G = 4082 + 0 + 2816 = 6897\ \text{J}$$

b) $$\Delta S = 1.751\times255.7\times\ln\frac{398.75}{323.15} +$$

$$+\frac{1.751\times41430}{398.75} + 1.751\times239\times\ln\frac{473.15}{398.75}$$

$$+ 1.751\times8.314\times\ln\frac{1.01}{0.5} =$$

$$= 94.1 + 181.9 + 71.6 + 10.2 = 357.8\ \text{J K}^{-1}$$

$$\Delta H = 1.751\times255.7\times(398.75-323.15)$$

$$+1.751\times41430 + 1.751\times239\times(473.15$$

$$-398.75 + 0 =$$

$$= 33846 + 72538 + 31133 + 0 = 137516\ \text{J}$$

$H = U + PV$

$\Delta H = \Delta U + \Delta(PV)$

$\Delta U = \Delta H - \Delta(PV)$

$P_i = 1.01\ bar \qquad V_i = 284.5\ cm^3$

$P_f = 0.5\ bar \qquad V_f = \dfrac{1.751 \times 0.08314 \times 473.15}{0.5}$

$= 137.75\ dm^3$

$\Delta U = 137516 - \left(0.5 \times 10^5 \times 137.75 \times 10^{-3} - 1.01 \times 10^5 \times 284.5 \times 10^{-6}\right) =$

$= 130658\ J$

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