(33) $m = 12{,}5\,g = 0{,}0125\,kg$

$M = 20{,}1797\,\frac{g}{mol}$

$T_1 = 33{,}5°C = 306{,}65\,K$

$V_1 = 32{,}8\,L = 0{,}0328\,m^3$

$p_{ex} = 4850\,Pa = const$

$\Delta V = 4{,}70\,L \longrightarrow V_2 = 37{,}5\,L = 0{,}0375\,m^3$

(a) irreversibel

$p_{ex} = const$

reversibel: $p_{ex} = p_{in}$

$p_{in} = const$ und $p_{ex} = const$

$\longrightarrow$ keine Expansion

(b) $W = -\int p\,dV = -p_{ex}\int dV$

$W = -p_{ex} \cdot \Delta V$

$W = -4850\,\frac{kg}{\cancel{m}\,s^2} \cdot 0{,}0047\,m^{\cancel{3}\,2}$

$W = -22{,}795\,\frac{kg\,m^2}{s^2}$

$$W = -22{,}8\ J$$

(c) reversibel ($p_{ex} \neq$ const)

$T =$ const

$$W = -\int p\,dV = -\int \frac{nRT}{V}\,dV$$

$$W = -nRT \int_{V_1}^{V_2} \frac{1}{V}\,dV$$

$$W = -nRT \cdot \ln \frac{V_2}{V_1}$$

$$n = \frac{m}{M} = \frac{12{,}5\ \cancel{g}}{20{,}1797\ \frac{\cancel{g}}{mol}}$$

$$n = 0{,}619434\ mol$$

$$W = -0{,}619434\ \cancel{mol} \cdot 8{,}31446\ \frac{J}{\cancel{mol}\,\cancel{K}} \cdot 306{,}65\ \cancel{K} \cdot \ln\left(\frac{37{,}5\ \cancel{K}}{32{,}8\ \cancel{K}}\right)$$

$$W = -211{,}4915\ J$$

$$W = -211\ J$$

(d) $\underline{\underline{\Delta U = 0}}$ (ideales Gas mit $T = \text{const}$)

$\Delta U = W + Q$

$$\left.\begin{array}{l} \Delta U = 0 \\ W < 0 \quad (\text{s. (c)}) \end{array}\right\} \quad \underline{\underline{Q > 0}}$$

$$\Delta H = \underbrace{\Delta U}_{=0} + \Delta(pV)$$

$(pV = nRT)$

$\Delta H = \Delta(nRT) = nR \cdot \Delta T$

$\Delta T = 0$ (isotherm) $\longrightarrow$ $\underline{\underline{\Delta H = 0}}$

34 $n = 2{,}55$ mol

$p_1 = 1{,}55$ bar

$\big\downarrow$ $T = \text{const}$

$p_2 = 4{,}68$ bar

(a) $\Delta S_{\text{Gas}} = ?$

$$\Delta S_{\text{Gas}} = nR \left(\frac{5}{2} \ln \frac{T_2}{T_1} - \ln \frac{p_2}{p_1} \right)$$

$$\underbrace{\qquad\qquad}_{\substack{=0 \\ (T = \text{const})}}$$

$$\Delta S_{gas} = -nR \cdot \ln \frac{p_2}{p_1}$$

$$= -2{,}55\ \cancel{mol} \cdot 8{,}31446 \frac{J}{\cancel{mol}\,K} \cdot \ln\left(\frac{4{,}68\ \cancel{bar}}{1{,}55\ \cancel{bar}}\right)$$

$$\Delta S_{gas} = -23{,}429 \frac{J}{K}$$

$$\Delta S_{gas} = -23{,}4 \frac{J}{K}$$

(b) reversibel $\xrightarrow{2.\ HS}$ $\Delta S_{ges} = 0$

$$\Delta S_{ges} = \Delta S_{gas} + \Delta S_{Umgebung}$$

$$\Delta S_{Umgebung} = -\Delta S_{gas} = 23{,}4 \frac{J}{K}$$

35 $\quad C_p(T) = 16{,}58 + 0{,}4245 \cdot T$

$$\frac{J}{K} \qquad \frac{J}{K^2}$$

(a) $[C_p] = \frac{J}{K}$

$[T] = K$

$$\underline{\underline{C_p(T) = 16{,}58\,\frac{J}{K} + 0{,}4245\,\frac{J}{K^2} \cdot T}}$$

(b) $T_1 = 325{,}5\ K$

$T_2 = 412{,}4\ K$

$n = 3{,}25\ mol$

$$W = -\int p\,dV = -p\,(V_2 - V_1)$$

$$W = -pV_2 + pV_1 = -p_2V_2 + p_1V_1 \qquad (p_1 = p_2 = p)$$

$$(pV = nRT)$$

$$W = nRT_1 - nRT_2 = nR\,(T_1 - T_2)$$

$$W = 3{,}25\,\cancel{mol} \cdot 8{,}31448\,\frac{J}{\cancel{mol}\,\cancel{K}}\,(325{,}5\,\cancel{K} - 412{,}4\,\cancel{K})$$

$$W = -2348{,}217\ J$$

$$\underline{\underline{W = -2{,}35\ kJ}}$$

$$\left(W = -nR\,(T_2 - T_1) \right)$$

$$\left(\begin{aligned} W &= -nR\,(T_2 - T_1) \\ W &= -nR \cdot \Delta T \end{aligned} \right)$$

$$\Delta U = W + Q$$

$$Q = C \cdot \Delta T = C_p \cdot \Delta T$$

Achtung: $C_p = C_p(T)$!!

C_p ist veränderlich!

$$Q = \int C_p \, dT$$

$C_p(T)$

$$Q = \int_{T_1}^{T_2} \left(16{,}58 \frac{J}{K} + 0{,}4245 \frac{J}{K^2}\, T\right) dT$$

$$Q = \left[T \cdot 16{,}58 \frac{J}{K} + \frac{0{,}4245}{2} \frac{J}{K^2}\, T^2 \right]_{325{,}5\,K}^{412{,}4\,K}$$

$$Q = 16{,}58 \frac{J}{\cancel{K}} \left(412{,}4\,\cancel{K} - 325{,}5\,\cancel{K}\right) +$$

$$+\ 0{,}21225 \frac{J}{\cancel{K^2}} \left(412{,}4^2\,\cancel{K^2} - 325{,}5^2\,\cancel{K^2}\right)$$

$$Q = 1440{,}802\,J + 13610{,}215\,J$$

$$Q = 15051{,}017\,J$$

$$Q = 15{,}05 \text{ kJ}$$

$$\Delta U = W + Q$$

$$\Delta U = -2{,}35 \text{ kJ} + 15{,}05 \text{ kJ}$$

(Signifikant aus NK Stellen!)

$$\Delta U = 12{,}70 \text{ kJ}$$

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

$$\Delta H = \Delta U + \Delta(nRT) \qquad (pV = nRT)$$

$$\Delta H = \Delta U + nR \cdot \Delta T$$

$$W = -nR \cdot \Delta T$$

$$nR \cdot \Delta T = -W$$

$$\Delta H = \Delta U - W$$

$$\Delta U = W + Q$$

$$\Delta U - W = Q$$

$$\Delta H = Q$$

$$\Delta H = 15{,}05 \text{ kJ}$$