Übungsaufgaben VII, von 5.06.2001

Musterlösungen

1. Matterhorn = 4450m, Zermatt= 1800m, Δh=2650m, p=1 bar, T=310.15 K.
$\Delta H_{Verbrennung}$=-2808 kJ/mol; ΔS = + 182.4 J/K

$$\Delta W_e^{Max} = \Delta G$$
$$= -2808\ \mathrm{kJ} - (310.15\ \mathrm{K}) \cdot (182.4\ \mathrm{J/K})$$
$$= -2864.57\ \mathrm{kJ/mol}$$
$$\text{mit}\ \ M = 90\ \mathrm{kg}$$
$$\Delta W = \Delta h \cdot M \cdot g \qquad \text{reine Steigarbeit (Pot. Energie); in Wirklichkeit mehr } \Delta W \text{ wird benötigt, da } \eta \neq 1$$
$$\text{mit}\ \ 1\mathrm{g}\ \mathrm{Glucose} = 1/180\ \ \mathrm{mol}$$
$$M_{mol} = 6 \cdot 12 + 12 \cdot 1 + 6 \cdot 16 = 180\mathrm{g}$$
$$\Delta h = \frac{n}{M_{mol}} \cdot \frac{|\Delta G|}{M \cdot g}; \text{wo n ist die Menge von Glucose in Gram.}$$
$$2650 = \frac{n}{180} \cdot \frac{|-2865.57 \cdot 10^3|}{90 \cdot 9.81}$$
$$n = 147.04\ \mathrm{g} \approx 0.82\ \mathrm{mol}$$

2.

$$dH = TdS + VdP$$
$$\left(\frac{\partial H}{\partial P}\right)_T = T\left(\frac{\partial S}{\partial P}\right)_T + V \xrightarrow{\text{Maxwell-Relationen}} \left(\frac{\partial H}{\partial P}\right)_T = V - T\left(\frac{\partial V}{\partial T}\right)_P = V(1-\alpha T)$$
$$\text{wobei}\ \ \alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$$

3.

$$\left(\frac{\partial H}{\partial P}\right)_T = V(1-\alpha T)$$

$\alpha = 1.237 \cdot 10^{-3}\ K^{-1}$; T = 25°C = 298,15 K; $\rho = 0.879\ g.cm^{-3}$; $M_{Benzol} = 78,11\ g.mol^{-1} = 0,07811\ kg.mol^{-1}$

$$V_{1\,mol\,Benzol} = \frac{0,07811}{0,879\times10^{-3}} = 88,86\times10^{-6}\ m^3mol^{-1}$$

$$\left(\frac{\partial H}{\partial P}\right)_T = 88,86\times10^{-6}\times0,63118845 = 5,61\times10^{-5}\,m^3mol^{-1}$$

$$\Delta H = 5,61\times10^{-5}\,m^3mol^{-1}\times10\times10^5\,Pa = 56,1\,J.mol^{-1}$$

4.

$$A = U - TS \rightarrow dA = dU - TdS - SdT$$

$$dU = dQ + dW = TdS - PdV$$

$\rightarrow$ dA = -PdV –SdT. Daraus folgt $P = -\left(\frac{\partial A}{\partial V}\right)_T$

$$P = -\frac{\partial}{\partial V}\left(-\frac{a}{V_m} - RT\ln(V_m - b) + f(T)\right)_T = \frac{\partial}{\partial V}\left(\frac{a}{V_m} + RT\ln(V_m - b)\right)_T$$

$$P = -\frac{a}{V^2{}_m} + \frac{RT}{(V_m - b)}$$ (Van-der-Waals-Gleichung)