

1) Izračunaj spremembo entropije 10 molov vode, če jo segrejemo pri $P = 2 \text{ Bar}$ od 10°C do 200°C . Na voljo imaš naslednje podatke:

tekoča voda - $c_p = 75,31 \text{ (J/mol K)}$

H_2O para - $c_p = 30,00 + 10,71 \cdot 10^{-3}T + 0,33 \cdot 10^{-5}T^2 \text{ (J/mol K)}$

$\Delta H_{100}^\circ \text{ (pri } 100^\circ\text{C)} = 41,09 \text{ kJ/mol}$

2) Znano je, da pri adiabatni reverzibilni ekspanziji idealnega plina tlak hitreje pada z volumnom kot pri reverzibilni izotermni ekspanziji tega plina. Če veš, da je za plin $(\gamma)_{\text{pl}} = 3/2$, določi, kolikokrat je naklon $(\partial P/\partial V)$ za izotermno ekspanzijo manjši od naklona za adiabatno ekspanzijo.

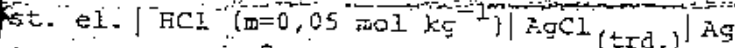
3) Iz zaprtega tanka delno napoljenega z vodo pri temperaturi 82°C počasi izsesavamo plinasto fazo. Izračunaj, pri katerem tlaku bo začela voda vreti!

ΔH_{100}° za vodo = 2260 J/g

4) Koncentracija vodne raztopine neke snovi, ki v vodi ne disociira, je podana z molalno udeležbo te snovi, $x_2 = 0,1$. Kolikšna bo temperatura križišča raztopine, če se ta obnaša idealno in je krioskopska konstanta enaka $k_2 = 1,86 \text{ K mol}^{-1} \text{ kg}$.

5) Za disociacijo $\text{PCl}_5 (\text{pl}) \rightarrow \text{PCl}_3 (\text{pl}) + \text{Cl}_2 (\text{pl})$ je pri 300°C $K_p = 8 \cdot 10^{-2}$. Izračunaj stopnjo disociacije pri dani temperaturi in celotnem tlaku $P = 2 \text{ At}$.

6) Za galvanski člen:



izmerimo pri 25°C napetost $0,5084 \text{ V}$. Vrednosti za standardna elektrodna potenciala poznamo; $E^\circ_{\text{st. el.}} = -0,1262 \text{ V}$

$E^\circ_{\text{Ag/AgCl/Cl}^-} = 0,2224 \text{ V}$. Izračunaj:

- a) srednji koeficient aktivnosti solne kisline,
- b) aktivnost solne kisline, $a = 0,0446$
- c) pH (predpostavi, da je $\gamma_{\text{H}^+} = \gamma_{\text{Cl}^-}$).

Handwritten notes and calculations:
 $\Delta T = \frac{m \cdot k_2}{x_2} = \frac{0,1 \cdot 1,86}{0,1} = 1,86^\circ\text{C}$
 $T = 82^\circ\text{C} - 1,86^\circ\text{C} = 80,14^\circ\text{C}$
 $\Delta H_{100}^\circ = 2260 \text{ J/g}$
 $\Delta H_{100}^\circ = 41,09 \text{ kJ/mol}$
 $K_p = 8 \cdot 10^{-2}$
 $P = 2 \text{ At}$
 $\alpha = 0,04$
 $\alpha = 1,26 \cdot 10^{-1}$
 $E = 0,5084 \text{ V}$
 $E^\circ_{\text{st. el.}} = -0,1262 \text{ V}$
 $E^\circ_{\text{Ag/AgCl/Cl}^-} = 0,2224 \text{ V}$
 $a = 0,0446$
 $\text{pH} = 1,35$

IZPIT, 29.3.1993

①

$n = 10 \text{ mol H}_2\text{O}$

$P = 1 \text{ bar}$

$T_1 = 10^\circ\text{C} = 283\text{K}$

$T_2 = 200^\circ\text{C} = 473\text{K}$

$C_p(\text{tekoča voda}) = 75,31 \text{ J/mol}\cdot\text{K}$

$C_p(\text{vodna para}) = 30,00 + 10,71 \cdot 10^{-3} T + 0,33 \cdot 10^{-5} T^2 \text{ [J/mol}\cdot\text{K]}$

$\Delta H_{\text{izp}}(T=100^\circ\text{C}) = 41,09 \text{ kJ/mol}$

① segrevanje vode $10^\circ - 100^\circ\text{C}$

② 100° izparevanje

③ $100^\circ - 200^\circ$ - segrevanje pare

$\Delta S_1 = n \cdot C_p \cdot \ln \frac{T_2}{T_1} = 10 \text{ mol} \cdot 75,31 \text{ J/mol}\cdot\text{K} \cdot \ln \frac{373}{283}$

$\Delta S_1 = 2077,9 \text{ J/K}$

$\Delta S_2 = \frac{n \cdot \Delta H_{\text{izp}}}{T} = \frac{10 \text{ mol} \cdot 41090 \text{ J/mol}}{373\text{K}}$

$\Delta S_2 = 1101,6 \text{ J/K}$

$\Delta S_3 = n \int_{T_1}^{T_2} \frac{C_p}{T} dT = n \int_{T_1}^{T_2} \frac{30,00 + 10,71 \cdot 10^{-3} T + 0,33 \cdot 10^{-5} T^2}{T} dT$

$\Delta S_3 = n \int_{T_1}^{T_2} \left(\frac{30,00}{T} + 10,71 \cdot 10^{-3} + 0,33 \cdot 10^{-5} T \right) dT$

$\Delta S_3 = n \cdot \left(30,00 \ln \frac{T_2}{T_1} + 10,71 \cdot 10^{-3} [T_2 - T_1] + \frac{1}{2} \cdot 0,33 \cdot 10^{-5} (T_2^2 - T_1^2) \right)$

$\Delta S_3 = 10 \text{ mol} \cdot \left(30 \ln \frac{473}{283} + 10,71 \cdot 10^{-3} [473 - 283] + \frac{1}{2} \cdot 0,33 \cdot 10^{-5} (473^2 - 283^2) \right) \frac{\text{J}}{\text{mol}\cdot\text{K}}$

$\Delta S_3 = 8214 \text{ J/K}$

$\Delta S = \Delta S_1 + \Delta S_2 + \Delta S_3 = 2077,9 \text{ J/K} + 1101,6 \text{ J/K} + 8214 \text{ J/K}$

$\Delta S = 11391,9 \text{ J/K}$

②

ADIB.

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$P \cdot V^\gamma = \text{konst.}$

$P \cdot V = \text{konst.}$

$P \cdot dV^\gamma + \gamma \cdot V^{\gamma-1} \cdot dP = 0$

$PdV + VdP = 0$

$P \cdot dV^\gamma + \gamma \cdot V^{\gamma-1} \cdot dP = -V^{\gamma-1} \cdot dP$

$PdV = -VdP$

$\left(\frac{dP}{dV}\right) = -\frac{P \cdot \gamma \cdot V^{\gamma-1}}{V^\gamma} = -\frac{P \cdot \gamma}{V}$

$\left(\frac{dP}{dV}\right) = -\frac{P}{V}$

$\gamma = \frac{5}{2} R, C_p = C_v + R = \frac{5}{2} R, \gamma = \frac{C_p}{C_v} = \frac{\frac{5}{2} R}{\frac{3}{2} R} = \frac{5}{3}$

$$\left(\frac{dp}{dv}\right) : \left(\frac{dp}{dv}\right) = - \frac{P^{5/3}}{V} \cdot \left(-\frac{V}{P}\right) = \frac{5}{3}$$

ka adiabatis je $5/3 \times$ manji.

ka izotermska je $3/2 \times$ manji kot ka adiabatis.

3) $T = 82^\circ\text{C} = 355,15\text{K}$

$$\Delta H_{izp} = 2260 \text{ J/g} \cdot 20$$

$$T = ?$$

$$\ln \frac{P}{P_0} = - \frac{\Delta H_{izp}}{R} \left(\frac{1}{T} - \frac{1}{T_0} \right)$$

$P_0 = 1,013 \cdot 10^5 \text{ Pa}$
 $T_0 = 273,15 \text{ K}$
 $\frac{1}{2} \text{ mol K} \cdot \frac{1}{\text{mol}}$
 $\frac{1}{2} \cdot 2 \cdot 10^{-2} \text{ mol}$

$$P = 0,52117 \cdot 10^5 \text{ Pa}$$

0,5111 mol 5,2110 Pa

NOTE!

4) $X_2 = 0,1$

$$K_k = 1,86 \frac{\text{K} \cdot \text{kg}}{\text{mol}}$$

$$\Delta T = K_k \cdot m$$

Zalozi me

$$\Delta T = 1,86 \frac{\text{K} \cdot \text{kg}}{\text{mol}} \cdot 0,17 \frac{\text{mol}}{\text{kg}}$$

$$X_2 = M_2 \cdot N_2$$

$$X_2 = \frac{n_2}{n_1 + n_2} = \frac{y_2}{x_2 \cdot m}$$

$$\Delta T = 11,42 \text{ K}$$

$$0,1 = \frac{5,556 \cdot x_2}{5,556 + x_2 \cdot m}$$

$$m \cdot x_2 = 30$$

$$5,556 + 0,1 m = m$$

$$T_2 = -11,42^\circ\text{C}$$

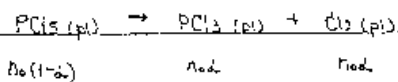
$$1 \cdot (20 \text{ mol}) = 2 \cdot \text{mol}$$

$$5,556 = 0,9 m$$

ix

$$m = 6,17 \frac{\text{mol}}{\text{kg}}$$

5)



$$T = 300^\circ\text{C}$$

$$K_p = 8 \cdot 10^{-9}$$

$$P = 2 \text{ at}$$

$$d = ?$$

$$K_p = \frac{\frac{d}{1+d} \cdot P \cdot \frac{d}{1+d} \cdot P}{\frac{1-d}{1+d} \cdot P} = \frac{d^2 \cdot P}{1-d^2}$$

$$n = n_0(1-d) + n_{od} + n_{od} = n_0(1-d+d+d) = n_0(1+d)$$

$$X_1 = \frac{1-d}{1+d}$$

$$X_2 = \frac{n_{od}(1+d)}{n_0(1+d)}$$

$$X_i = \frac{n_i}{n}$$

$$X_1 = X_2 = \frac{d}{1+d}$$

$$8 \cdot 10^{-9} = \frac{2 \cdot \frac{2A}{1-A}}{1-\delta^2}$$

$$8 \cdot 10^{-9} - 8 \cdot 10^{-9} \delta^2 = 2 \delta^2$$

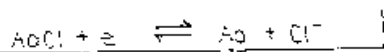
$$8 \cdot 10^{-9} = 2,000000008 \delta^2$$

$$\delta = 6,32 \cdot 10^{-5} \quad \checkmark$$

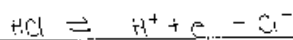
st. el. | HCl (m = 0,05 mol·kg⁻¹) | AgCl (vad) | Ag

T = 25°C

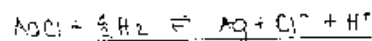
$$E = 0,5084 \text{ V}$$



$$E_{\text{AgCl}}^{\circ} = -0,2262 \text{ V}$$



$$E_{\text{Ag/AgCl/Cl}^-}^{\circ} = 0,2224 \text{ V}$$



$$\delta_{\pm} = ? \quad a_{\text{HCl}} = ?$$

$$\text{pH} = ? \quad (\delta_{\text{H}^+} = \delta_{\text{Cl}^-})$$

$$E_{\text{AgCl}}^{\circ} - E_{\text{Ag}}^{\circ}$$

$$E = E^{\circ} - \frac{RT}{F} \ln (a_{\text{H}^+} \cdot a_{\text{Cl}^-})$$

$$a_{\pm} = a_{\text{H}^+} \cdot a_{\text{Cl}^-} = m_{\text{H}^+} \cdot m_{\text{Cl}^-} = m^2 \delta_{\pm}^2$$

$$E^{\circ} - E = \frac{RT}{F} \ln (m^2 \delta_{\pm}^2)$$

$$\delta_{\pm} = 0,89$$

$$a_{\text{HCl}} = 1,98 \cdot 10^{-3} \frac{\text{mol}}{\text{kg}}$$

$$\text{pH} = -\log a_{\text{H}^+}$$

$$a_{\text{H}^+} = m \cdot \gamma_{\text{H}^+} = 0,05 \cdot 0,89$$

$$\text{pH} = 1,35$$

$$= 0,0445$$