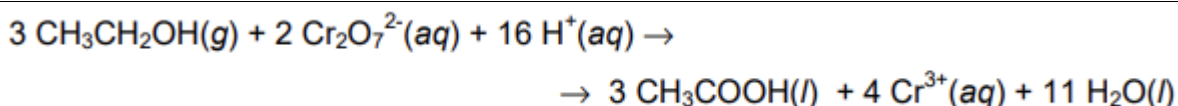


1. uzdevums – Alkohola testeris (11 % no kopējā)

1. uzdevums (11%)	Jautājums	1	2	3	4	5	6	Summa
	Punkti	2	2	1	4	2	5	16
	Rezultāts							

1. Uzrakstiet balancētu ķīmiskās reakcijas vienādojumu etanola oksidēšanas reakcijai ar dihromātu ($\text{Cr}_2\text{O}_7^{2-}$) skābā ūdens šķīdumā. *Padoms: Kā viens no produktiem rodas Cr^{3+}*



2. Aprēķiniet standarpotenciālu E° kopējai reakcijai (1. punkta atbilde).

$$E^\circ = 1.330 - 0.058 = 1.272 \text{ V}$$

3. Pamatojoties uz 2. punktā izrēķināto atbildi, nosakiet vai reakcija ir spontāna pie 25 °C un 1.0 bar spiediena.

- Reakcija ir spontāna
 Reakcija nav spontāna
 Nav nosakāms

Vērtējot punkts tiek piešķirts par atbildi, kas atbilst 2. punktā sniegtajai atbildei, tas ir, $E > 0$ spontāna, $E < 0$ nav spontāna.

4. Nosakiet etanola masu elpā, kas tika iepūsta testerī.

$$Q = I \cdot t = 0.1 \text{ A} \times 60 \text{ s} = 6.0 \text{ A s} = 6.0 \text{ C}$$

According to the balanced reaction equation, 6 mol e^- produces 2 mol Cr^{3+} .

$$\text{Therefore: } n(\text{Cr}^{3+}) = 6.0 \text{ C} \frac{2 \text{ mol Cr}^{3+}}{6 \times 96485 \text{ C}} = 2.07 \cdot 10^{-5} \text{ Cr}^{3+}$$



$$n(\text{alcohol per volume of exhaled breath}) = 1.55 \cdot 10^{-5} \text{ mol}$$

$$m(\text{alcohol per volume of exhaled breath}) = 1.55 \cdot 10^{-5} \times 46.0 \text{ g mol}^{-1} = 7.15 \cdot 10^{-4} \text{ g}$$

5. Nosakiet alkohola saturu asinīs, izteiktu gramos uz cm^3 .

$7.15 \cdot 10^{-4}$ g of alcohol in 60 cm^3 expired air

$1.19 \cdot 10^{-5}$ g/ cm^3 expired air

$1.19 \cdot 10^{-5}$ g/ cm^3 expired air $\times 2100 = 0.025$ g alcohol in 1 cm^3 blood.

6. Aprēķiniet reducēšanās standartpotenciālu $\text{Cr}(\text{OH})_3$ reducēšanai par Cr.

Cell reaction should be: $\text{Cr}(\text{OH})_3(\text{s}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{OH}^{-}(\text{aq})$

Suitable cell for this reaction: $\text{Cr}(\text{s}) | \text{Cr}^{3+}(\text{aq}) | \text{OH}^{-}(\text{aq}) | \text{Cr}(\text{OH})_3(\text{s}) | \text{Cr}(\text{s})$

$$\Delta G^{\circ} = -3 \times 96485 \times E_{\text{cell}}^{\circ} = -8.314 \times 298 \ln K_s$$

$$E_{\text{cell}}^{\circ} = \left(\frac{8.314 \times 298}{3 \times 96485} \right) \ln 6.31 \times 10^{-31} = -0.595 \text{ V}$$

$$-0.595 = E_{\text{cathode}}^{\circ} - (-0.74) \quad E_{\text{cathode}}^{\circ} = -1.34 \text{ V}$$

2. uzdevums – Kinētika gāzes fāzē (11 % no kopējā)

2. uzdevums (11%)	Jautājums	1	2	3	4	5	Summa
	Punkti	3	3	1	3	6	16
	Rezultāts						

1. Nosakiet reakcijas pakāpes attiecībā pret vielām A₂, B un C.

From exp. 1 and 2: $\left(\frac{3.200 \cdot 10^{-10}}{1.600 \cdot 10^{-10}}\right) = \frac{k [0.01]^x [0.20]^y}{k [0.01]^x [0.10]^y}$ Thus: $y = 1$

From exp 3 and 2: $\left(\frac{10.12 \cdot 10^{-10}}{3.200 \cdot 10^{-10}}\right) = \frac{k [0.10]^x [0.20]^y}{k [0.010]^x [0.20]^y}$ Thus: $x = 0.5$

Therefore, the rate of the reaction = $k [A_2]^{1/2} [B_2] [C] = k_{\text{overall}} [A_2]^{1/2} [B_2]$

2. Nosakiet reakcijas ātruma konstanti k pie 400 K.

$$k_{\text{overall}} = k[C]$$

$$\text{Rate} = 1.600 \cdot 10^{-10} = k_{\text{overall}} \times 0.01^{1/2} \times 0.1$$

$$k_{\text{overall}} = 1.6 \cdot 10^{-8} \text{ dm}^{3/2} \text{ mol}^{-1/2} \text{ s}^{-1}$$

3. Parādiet, ka piedāvātais mehānisms pareizi apraksta kopējo reakciju.

After multiplying second and third reaction equations by two and adding the three steps, overall reaction equation is found; $A_2(g) + 2 B(g) \rightarrow 2 AB(g)$

4. Nosakiet sakarību starp reakcijas konstanti k un konstantēm (k_1 , k_{-1} , k_2 , k_3).

$$\text{Rate of disappearance of B} = -\frac{\Delta[B]}{\Delta t} = k_2[A][B][C] \quad \checkmark$$

$$\text{From fast equilibrium } [A] = \sqrt{\frac{k_1}{k_{-1}}} \times \sqrt{[A_2]}$$

$$\text{Rate of disappearance of B} = k_2 \left(\sqrt{\frac{k_1}{k_{-1}}} \right) [A_2]^{1/2} [B][C] \quad \checkmark$$

$$\text{Since the rate of the reaction is } -\frac{\Delta[A_2]}{\Delta t} = -\frac{1}{2} \frac{\Delta[B]}{\Delta t} = \frac{1}{2} \frac{\Delta[B]}{\Delta t}$$

$$\text{Rate of the reaction} = \frac{1}{2} k_2 \left(\sqrt{\frac{k_1}{k_{-1}}} \right) [A_2]^{1/2} [B][C] = k_{\text{overall}} [A_2]^{1/2} [B_2]$$

$$k_{\text{overall}} = \frac{1}{2} k_2 \left(\sqrt{\frac{k_1}{k_{-1}}} \right) [C] \quad \checkmark$$

5. Aprēķiniet disociācijas entalpiju saitei savienojumā A_2 .

$$\text{Since } k_{\text{overall}} = \frac{1}{2} k_2 \left(\sqrt{\frac{k_1}{k_{-1}}} \right) [C]$$

In order to find dissociation enthalpy of A_2 we should find k_2 both at 400 and 425 K

$$\frac{k_1}{k_{-1}} = (4.0 \cdot 10^{-3})^2 / 0.10 = 1.6 \cdot 10^{-4} \quad \checkmark$$

$$k_{\text{overall}} = \frac{1}{2} k_2 \sqrt{1.6 \cdot 10^{-4}} \times 0.050 = 1.6 \cdot 10^{-8} \quad k_2(400) = 5.1 \cdot 10^{-5} \quad \checkmark$$

$$\ln \frac{k_2}{5.06 \cdot 10^{-5}} = \frac{45000}{8.314} \times \left(\frac{25}{400 \times 425} \right) \quad k_2(425) = 1.1 \cdot 10^{-4} \quad \checkmark$$

At 425 K the rate in the first experiment increases 3-times. Therefore:

$$k_{\text{overall}} \text{ at 425 K: } k_{\text{overall}} = \frac{3 \times 1.6 \cdot 10^{-8}}{0.01^{1/2} \times 0.1} = 4.8 \cdot 10^{-8} \quad \checkmark$$

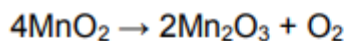
$$k_{\text{overall}} = \frac{1}{2} \times 1.12 \cdot 10^{-4} \times \sqrt{\frac{k_1}{k_{-1}}} \times 0.05 = 4.8 \cdot 10^{-8}$$

$$\sqrt{\frac{k_1}{k_{-1}}} \cdot 1.71 \cdot 10^{-2} \quad k(425) = \frac{k_1}{k_{-1}} = 2.93 \cdot 10^{-4} \quad \checkmark$$

3. uzdevums – Termodinamika (8 % no kopējā)

3. uzdevums (8%)	Jautājums	1	2	3	Summa
	Punkti	6	1	4	11
	Rezultāts				

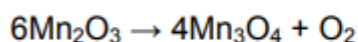
1. Aprēķiniet sadalīšanās temperatūru (T_1 , T_2 , T_3) katram oksīdam.



$$\Delta_r H^\circ = -957,7 \cdot 2 + 0 - (-521,5) \cdot 4 = 170,6 \text{ kJ} \cdot \text{mol}^{-1}$$

$$\Delta_r S^\circ = 110,4 \cdot 2 + 205,0 - 51,1 \cdot 4 = 221,4 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

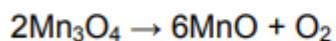
$$T_1 = 170600 \text{ kJ} \cdot \text{mol}^{-1} / 221,4 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \approx 770 \text{ K} \approx 500^\circ\text{C}$$



$$\Delta_r H^\circ = -1387,6 \cdot 4 + 0 - (-957,7) \cdot 6 = 195,8 \text{ kJ} \cdot \text{mol}^{-1}$$

$$\Delta_r S^\circ = 154,8 \cdot 4 + 205,0 - 110,4 \cdot 6 = 161,8 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

$$T_2 = 195800 \text{ kJ} \cdot \text{mol}^{-1} / 161,8 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \approx 1210 \text{ K} \approx 940^\circ\text{C}$$

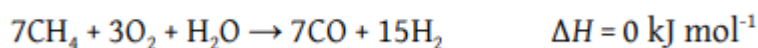


$$\Delta_r H^\circ = -385,1 \cdot 6 + 0 - (-1387,6) \cdot 2 = 464,6 \text{ kJ} \cdot \text{mol}^{-1}$$

$$\Delta_r S^\circ = 61,5 \cdot 6 + 205,0 - 154,8 \cdot 2 = 264,4 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

$$T_3 = 464600 \text{ kJ} \cdot \text{mol}^{-1} / 264,4 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \approx 1760 \text{ K} \approx 1480^\circ\text{C}$$

2. Uzrakstiet kopējo reakciju (3), tā lai reakcijas entalpijas izmaiņa būtu nulle.



3. Aprēķiniet veikto darbu gāzu saspiešanai a) un b) gadījumos, ja saspiešana veikta pie temperatūras 500 K, izmantojot 100 molus izejvielu.

$$1) \quad w_2 = n_1 RT \ln \frac{P_1}{P_0} + n_2 RT \ln \frac{P_2}{P_0} = n_1 RT \left(\ln \frac{P_1}{P_0} + 2 \ln \frac{P_2}{P_0} \right)$$

$$100 \text{ mol} \cdot 8,314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 500 \text{ K} \cdot \left(\ln \frac{3 \text{ MPa}}{0,1 \text{ MPa}} + 2 \ln \frac{6 \text{ MPa}}{3 \text{ MPa}} \right) = 1,99 \text{ MJ}$$

$$2) \quad w_1 = n_2 RT \ln \frac{P_2}{P_0} = 200 \text{ mol} \cdot 8,314 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} \cdot 500 \text{ K} \cdot \ln \frac{6 \text{ MPa}}{0,1 \text{ MPa}} = 3,40 \text{ MJ}$$

Vārds, Uzvārds _____