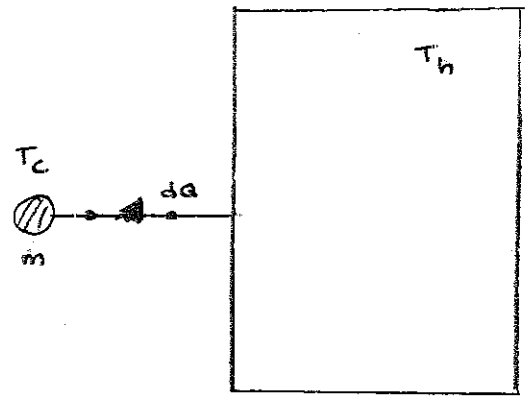
(1)

Givet: $m = 1{,}0\ \text{kg}$
$T_c = 10^\circ\text{C}$
$T_h = 100^\circ\text{C}$
$c = 4{,}18\ 10^3\ \text{J/kg·K}$

Sökt: ΔS_c & ΔS_{tot}



T = den momentana temperaturen i vattnet.

För att öka vattnets temperatur dT krävs att dQ tillförs

$$dQ = mc\,dT$$

Sammanlagt åtgår värmemängden Q för att öka temperaturen från T_c till T_h:

$$Q = m\,c\int_{T_c}^{T_h} dT = mc(T_h - T_c)$$

ΔS_h: När vattnet tillförs dQ är den stora reservoarens värmeutbyte $-dQ = -mc\,dT$

$$\Delta S_h = \int_i^f \frac{(-dQ)}{T_h} = \int_{T_c}^{T_h} -\frac{mc\,dT}{T_h} = \left[\text{m, c och } T_h \text{ är konstanter}\right] =$$

$$= -\frac{mc}{T_h}\int_{T_c}^{T_h} dT = -\frac{mc(T_h - T_c)}{T_h} = -1{,}0\cdot 4{,}18\cdot 10^3\,\frac{373 - 283}{373} =$$

$$= -1008{,}6\ \text{J/K}$$

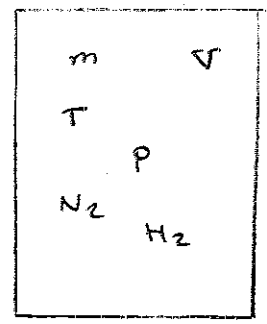
ΔS_c:

$$\Delta S_c = \int_i^f \frac{dQ}{T} = \int_{T_c}^{T_h} \frac{mc\,dT}{T} = mc\int_{T_c}^{T_h}\frac{dT}{T} = mc\ln\frac{T_h}{T_c} =$$

$$= 1{,}0\cdot 4{,}18\cdot 10^3\cdot \ln\frac{373}{283} = +1154{,}2\ \text{J/K}$$

$$\therefore\ \Delta S_{tot} = \Delta S_c + \Delta S_h = 1154{,}2 - 1008{,}6 = \underline{\underline{146\ \text{J/K}}}$$

(2)



Givet:

$m = 3530\ g$
$V = 40{,}0\ l$
$T = 25°C$
$p_{tot} = 140 \cdot 10^5\ N/m^2$

Sökt p_{N_2}

molvikter: H_2: 2 g N_2: 28 g

$n'_{H_2} \cdot 2 \cdot 10^{-3} + n'_{N_2} \cdot 28 \cdot 10^{-3} = m \Rightarrow n'_{H_2} = \frac{1}{2}(m - 28\, n'_{N_2})$ (1)

Dessutom gäller $(n'_{H_2} + n'_{N_2})RT = pV$ (idealgaslagen)

$= (p_{H_2} + p_{N_2})V$ (2)

(1) in i (2)

$$\Rightarrow n'_{N_2} = \frac{1}{13}\left(\frac{m}{2} - \frac{pV}{RT}\right) =$$

$$= \frac{1}{13}\left(\frac{3{,}530}{0{,}002} - \frac{140\ 10^5 \cdot 0{,}040}{8{,}31\ \ 298}\right) = 118{,}374\ mol$$

$$\text{men} \quad n'_{tot} = \frac{pV}{RT} = \frac{140 \cdot 10^5 \cdot 0{,}040}{8{,}31 \cdot 298} = 226{,}126\ mol$$

$$p_{N_2} = p\,\frac{n'_{N_2}}{n'_{tot}} = 140 \cdot 10^5\ \frac{118{,}374}{226{,}126} = \underline{\underline{73{,}3 \cdot 10^5\ N/m^2}}$$

③ Givet:

$1 \to 2$ adiabat

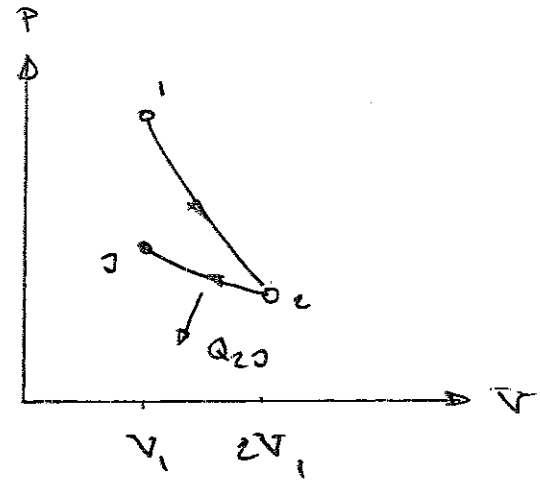
$V_2 = 2V_1$

$2 \to 3$ isoterm

$T_1 = 373\,K$

$Q_{23} = -2700\,J$

Sökt: antalet atomer per molekyl.



$$Q_{23} = n'RT_2 \cdot \ln\frac{V_1}{2V_1}$$

$$\Rightarrow T_2 = \frac{Q_{23}}{n'R \cdot \ln\frac{1}{2}} = \frac{-2700}{2{,}00 \cdot 8{,}31 \cdot \ln\frac{1}{2}} =$$

$$= 234{,}4\,K$$

Adiabat: $\left.\begin{matrix} p_1V_1^{\gamma} = p_2V_2^{\gamma} \\ pV = n'RT \end{matrix}\right\} \Rightarrow T_1V_1^{\gamma-1} = T_2(2V_1)^{\gamma-1}$

$$\Rightarrow T_1 \cdot V_1^{\gamma-1} = T_2 \cdot 2^{\gamma-1} \cdot V_1^{\gamma-1}$$

$$\Rightarrow 2^{\gamma-1} = \frac{T_1}{T_2}$$

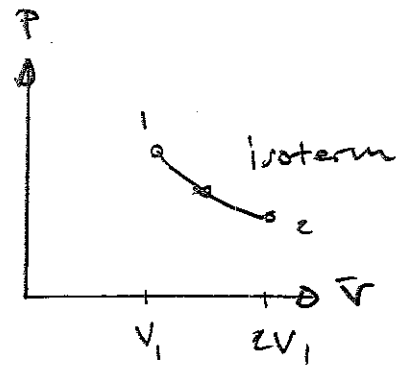
$$\Rightarrow (\gamma-1)\cdot\ln 2 = \ln\frac{T_1}{T_2}$$

$$\Rightarrow \gamma = 1 + \frac{\ln\frac{T_1}{T_2}}{\ln 2} = 1 + \frac{\ln\frac{373}{234{,}4}}{\ln 2} =$$

$$= 1{,}67 \approx \frac{5}{3} = \frac{C_p}{C_V}$$

∴ enatomiga molekyler

(4)



$$\Delta S = \int_1^2 \frac{dQ}{T} = \frac{1}{T} \int_1^2 dQ = \frac{1}{T} \cdot n' R T \ln \frac{2V_1}{V_1} =$$

$$= n' R \cdot \ln 2 = 5{,}76 \text{ J/K} =$$

$$= \underline{\underline{5{,}8 \text{ J/K}}}$$

(5)

n_2 ——— ε_2

n_1 ——— ε_1

Givet:

$\varepsilon_1 = 0{,}05$ eV

$\varepsilon_2 = 0{,}10$ eV

$g_2 = 2 g_1$

$T = 300$ K

$f_{MB}(\varepsilon) = \text{konst} \cdot e^{-\varepsilon/kT}$

$T = 300$ K

$\Rightarrow kT = 0{,}0259$ eV

Sökt: medelenergin $\langle \varepsilon \rangle$

$$n_1 = g_1 \cdot \text{konst} \cdot e^{-\varepsilon_1/kT}$$

$$n_2 = g_2 \cdot \text{konst} \cdot e^{-\varepsilon_2/kT}$$

$$\Rightarrow \frac{n_1}{n_2} = \frac{g_1}{g_2} e^{(\varepsilon_2 - \varepsilon_1)/kT} =$$

$$= \frac{1}{2} e^{0{,}05/0{,}0259} = 3{,}446 = x$$

$$\Rightarrow n_1 = x \cdot n_2$$

$$\langle \varepsilon \rangle = \frac{n_1 \cdot \varepsilon_1 + n_2 \varepsilon_2}{n_1 + n_2} = \frac{x \cdot n_2 \cdot \varepsilon_1 + n_2 \varepsilon_2}{x \cdot n_2 + n_2} =$$

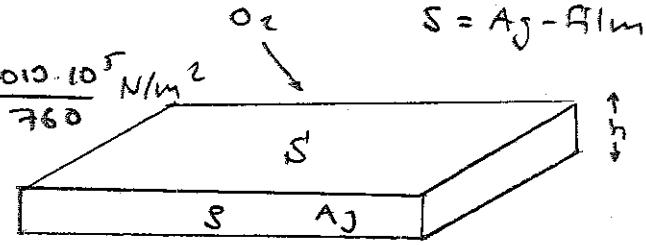
$$= \frac{x \cdot \varepsilon_1 + \varepsilon_2}{x + 1} =$$

$$= \frac{3{,}446 \cdot 0{,}05 + 0{,}10}{3{,}446 + 1} \text{ eV} =$$

$$= 0{,}0613 \text{ eV} = \underline{\underline{0{,}06 \text{ eV}}}$$

⑥ $1\,\text{torr} = \frac{1\,\text{atm}}{760} = \frac{1{,}013\cdot 10^5\ \text{N/m}^2}{760}$

$\rho_{Ag} = 10{,}5\cdot 10^3\ \text{kg/m}^3$



Givet: $h = 500\ \text{Å}$

$p = 1{,}0\cdot 10^{-10}$ torr

$N_O / N_{Ag} = 10/10^6 = 10\cdot 10^{-6}$

$T = 500\ \text{K}$

Sökt: Förangivna-hiden t.

O_2 molekylerna bombarderar Ag filmen.

Antal stötar under tiden t:

$$N = n^* \cdot S \cdot t$$

Varje stöt genererar 2 syreatomer i filmen:

$$\Rightarrow N_O = 2 \cdot n^* \cdot S \cdot t \quad (1)$$

$$n^* = \frac{1}{4} n \langle v \rangle \quad \text{där} \rightarrow \langle v \rangle = \sqrt{\frac{8RT}{\pi \cdot M_{mol\,O_2}}} = \sqrt{\frac{8\cdot 8{,}31\cdot 500}{\pi\cdot 0{,}032}} = 575\ \text{m/s}$$

$$\rightarrow n = \frac{p}{kT} = \frac{1{,}013\cdot 10^5 \cdot 1{,}0\cdot 10^{-10}}{760\cdot 1{,}38\cdot 10^{-23}\cdot 500} =$$

$$= 1{,}93\cdot 10^{12}\ \text{m}^{-3}$$

En silverfilm som har ytan S och tjocklekan h har massan $S\cdot h\cdot \rho_{Ag}$

En Ag-atom har massan $m_{Ag} = 1{,}8\cdot 10^{-25}$ kg

Silverfilmen innehåller alltså $N_{Ag} = \frac{S\cdot h\cdot \rho_{Ag}}{m_{Ag}}$ silveratomer

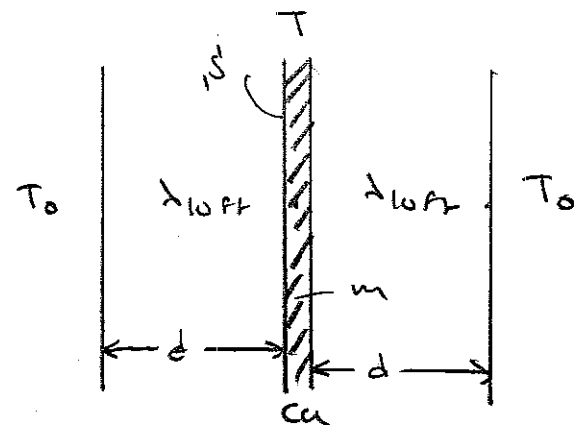
$$N_O = 10\cdot 10^{-10}\ N_{Ag} = 10\cdot 10^{-6}\ \frac{S\cdot h\cdot \rho_{Ag}}{m_{Ag}} = \text{enligt (1)} =$$

$$= 2\cdot \frac{1}{4} n\langle v\rangle \cdot S\cdot t$$

$$\Rightarrow t = \frac{h\cdot \rho_{Ag}\cdot 10\cdot 10^{-6}}{m_{Ag}\cdot \frac{2}{4}\cdot n\langle v\rangle} = \frac{500\cdot 10^{-10}\cdot 10{,}5\cdot 10^3\cdot 10\cdot 10^{-6}\cdot 2}{1{,}8\cdot 10^{-25}\cdot 1{,}93\cdot 10^{12}\cdot 575}\ \text{s}$$

$$= \underline{\underline{52\ \text{s}}}$$

(7)



Givet:

$S = 25\,cm^2 = 25 \cdot 10^{-4}\,m^2$

$d = 2{,}0\,mm$

$T_i = 20°C$

$T_0 = 0°C$ $\quad m = 0{,}022\,kg$

Sökt: t då $T = 10°C$ i Cu-skivan.

ur tabell: $\lambda_{luft} = 0{,}024\ W/m \cdot K$

$c_{Cu} = 0{,}39 \cdot 10^3\ J/kg \cdot K$

Ledning åt två håll $\Rightarrow -\frac{dQ}{dt} = \lambda_{luft}(2S)\frac{T-T_0}{d}$

$-dQ = -mc \cdot dT \Rightarrow -\frac{dQ}{dt} = -mc\frac{dT}{dt}$

$\therefore -mc\frac{dT}{dt} = \lambda_{luft} \cdot 2S \cdot \frac{T-T_0}{d}$

$$\Rightarrow -\frac{mcd}{2\lambda_{luft} \cdot S}\int_{T_i}^{T_f}\frac{dT}{T-T_0} = \int_0^t dt$$

$$\Rightarrow t = -\frac{mcd}{2\lambda_{luft} \cdot S}\left[\ln(T_f - T_0) - \ln(T_i - T_0)\right] =$$

$$= -\frac{mcd}{2\lambda_{luft} \cdot S}\ln\frac{T_f - T_0}{T_i - T_0} =$$

($\ln\frac{1}{2} < 0$)

$$= -\frac{0{,}022 \cdot 0{,}39 \cdot 10^3 \cdot 2{,}0 \cdot 10^{-3}}{2 \cdot 0{,}024 \cdot 25 \cdot 10^{-4}}\ln\left(\frac{10-0}{20-0}\right) =$$

$$= \underline{\underline{99\,s}}$$