TFY 4115 - Høst 2016

Øving 9

Vsevolod Karpov - vsevolok

Oppgave 1

Gjetter: ca 1 kg per m^3

Utregning: $p = \frac{P}{T \cdot R_s}$

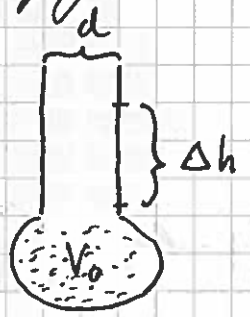
$P = 101.3\ kPa = 101.3 \cdot 10^3\ Pa$

$T = 20\ °C$, $R_s = 287\ J/kgK$

$T = 293.15\ K$

$\Rightarrow p = 1.204 \approx \underline{1\ kg\ per\ m^3}$

Oppgave 2



$\Delta V = \Delta h \cdot \pi \left(\frac{d}{2}\right)^2 =$

$1.00\ mm \cdot \pi (0.2\ mm)^2 = \underline{1.256 \cdot 10^{-10}\ m^3}$

$\frac{\Delta V}{\Delta \theta} \cdot \frac{V_1 - V_0}{\Delta T} = \beta = 0.001\ K^{-1}$

$\beta = \frac{dV}{dT} / V \Rightarrow V = \frac{dV}{dT} / \beta$

$\frac{dV}{dT} = \frac{\Delta V}{0.1°} = 1.256 \cdot 10^{-9} \Rightarrow V = 0.00000126\ m^3$

$= 0.00126\ L = \underline{\underline{1.3\ mL}}$

Oppgave 3 a) $R = 8.314\ m^3 Pa/(K^\circ mol)$

$n = 1.00\ mol$, $T = 20^\circ C$, $V = 24.0\ l$

$pV = nRT$

$\Rightarrow p = \frac{nRT}{V} \Rightarrow p_1 = \frac{293.15^\circ K}{0.024 m^3} \cdot R = 83333R$

$V = 0.24\ l = 0.00024\ m^3 \Rightarrow p_2 = 83333.33R = 100 p_1$

$\Rightarrow p_1 = 101552\ Pa$, $p_2 = 100 p_1$

b) $nRT = \left(p + \frac{n^2 a}{V^2}\right)(V - bn) = pV$

$\Rightarrow pV + \frac{n^2 a}{V} - pbn - \frac{bn^3 a}{V^2} = pV$

$\Rightarrow p = \frac{n^2 a}{Vbn} - \frac{n^2 a}{V^2} = \frac{n}{V}\left(\frac{a}{b} - \frac{na}{V}\right)$

$V_1 = 0.024 m^3$, $V_2 = 0.00024 m^3$

$n = 1\ mol = 1 \cdot 10^{-3}\ kmol$

$a = 1.368\ bar\left(\frac{m^3}{kmol}\right)^2 = 1.368 \cdot 10^5 Pa \left(\frac{m^3}{kmol}\right)^2$

$b = 0.0367\ m^3/kmol$

$\Rightarrow p_1 =$

$nRT = pV + \frac{n^2 a}{V} - pbn - \frac{bn^3 a}{V^2} = p(V - bn) + \frac{n^2}{V}\left(a - \frac{bn}{V}a\right)$

$\Rightarrow p = \frac{nRT - \frac{n^2}{V}\left(a - \frac{bn}{V}a\right)}{V - bn}$

$R = 8.314\ m^3 Pa/(K mol)$

$\Rightarrow p_1 = 1\ Atm$, $p_2 = 94.9\ Atm$

Oppgave 4

a) $800\,J - 300\,J = \underline{\underline{500\,J}}$

b) Samme indre energi uansett vei mot B

$\Rightarrow Q_{AOB} - 100\,J = 500\,J \Rightarrow Q_{AOB} = \underline{\underline{600\,J}}$

c) $\Delta U = -500\,J$ (går motsatt vei)

$U_A = U_B - 500\,J$

$\Delta U = Q - W = Q_{in} - Q_{ut} - (W_{in} - W_{ut})$

Arbeidet utføres på systemet: altså $-200\,J$

$\Rightarrow -500\,J = Q + 200\,J$

$\Rightarrow Q < 0$ (systemet avgir varme)

$\Rightarrow \underline{\underline{Q = -700\,J}}$

d) $U_A = 800\,J$, $U_D = 1200\,J$

$W_{AD} = 100\,J$

$U_D - U_A = \Delta U_{DA} = 400\,J$

$\Delta U_{DA} = Q_{AD} - W_{AD} = Q_{AD} - 100\,J$

$\Rightarrow \underline{\underline{Q_{AD} = 500\,J}}$

$\Delta U_{BA} = 500\,J \Rightarrow U_B = 1300$

$U_B - U_D = Q_{BD} - W_{BD} = Q_{BD} = \underline{\underline{100\,J}}$

Oppgave 5

$n = 2.00\ mol$, $T = 300\ K$

$\frac{V_1}{V_0} = 2.0$, $\Delta T = 0$

$pV = nRT$, $R = 8.314\ m^3 Pa / K\,mol$

$W = p\Delta V$

$\Delta U = Q - W = Q - p\Delta V = Q - pV$

$p_1 = \frac{nRT}{V_1}$, $p_2 = \frac{nRT}{2V_1} = \frac{1}{2}p_1$

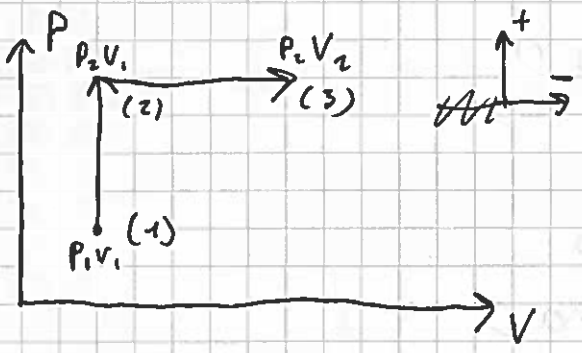
$W_{1\to 2} = \int_{V_1}^{V_2} p\,dV = \int_{V_1}^{V_2} \frac{nRT}{V}\,dV = nRT\left[\ln(V)\right]_{V_1}^{V_2}$

$= nRT\ln\left(\frac{V_2}{V_1}\right) = nRT\ln(2) = \underline{3.6\ kJ} = W$

Isotherm isk:

$\underline{\Delta U = 0} \Rightarrow \underline{Q = W = 3.6\ kJ}$

Oppgave 6



$T_2 = 2T_1$, $T_3 = T_1$

$W = p\Delta V$

$\Delta U = Q - W = 0$ $(\Delta T = 0)$

$\Delta U_{12} = Q = U_2 - U_1 = 2U_1 - U_1 = \underline{U_1}$

$\Delta U_{23} = -W = -U_1$

$p_1V_1 = nRT_1$

$p_2V_1 = nRT_2 = nRT_1 \cdot 2$ $\Rightarrow p_2 = 2p_1 \Rightarrow \Delta p = p_1$

$p_2V_2 = nRT_1 = p_1V_1$

$\frac{p_2}{p_1}V_2 = V_1 \Rightarrow V_2 = 2V_1 \Rightarrow \Delta V = V_1 \Rightarrow W = \int_{V_1}^{V_2} p_2\,dV = V_2p_2 - V_1p_2$

$= 4V_1p_1 - 2V_1p_1$

$\frac{p_2}{p_1} = 2 \Rightarrow 2V_2 = V_1 \Rightarrow V_2 = \frac{V_1}{2}$

$W = -\int_{V_1}^{V_2} p_2 \, dV = -(V_2 p_2 - V_1 p_2) = -(V_1 p_1 - 2V_1 p_1)$

$= \underline{\underline{V_1 p_1}}$ Begge

Oppgave 7.

a) Ball (A)

b) (B) $mg\cos(\theta)$

c) ~~(A) α~~ (B) 3α

Den lineære koofisienten beskriver utvidelse i kun en frihetsgrad
Volumutvidelse foregår i tre frihetsgrader: $a_V = 3a_L$

d) Smelting: 1.5 tidsenheter
Fordamping: 2.5 tidsenheter
Med andre ord, hvis det kreves en termisk arbeid på 1.5 J til å endre fase fra fast til væske, kreves 2.5 J for å endre fra væske til gass.

$\Delta m = 1 \Rightarrow Q_s = 1.5 = L_s \cdot \Delta m$

$Q_f = 2.5 = L_f \cdot \Delta m$

$\Rightarrow \frac{L_s}{L_f} = \frac{1.5}{2.5} = \underline{0.6}$ (B)