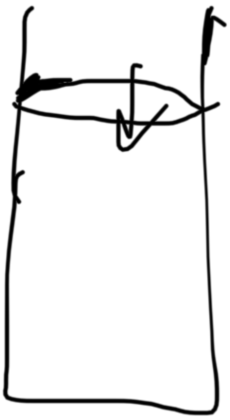
1.100.



$$\delta Q = 2\,dU$$

$$\Downarrow$$

$$\delta A = -2\,dU$$

$$pdV \qquad -\frac{15}{2} R\,dT$$

$$pV = RT$$

$$Vdp + pdV = R\,dT$$

$$pdV + \frac{15}{2} Vdp + \frac{15}{2} pdV = 0$$

$$17\,pdV + 15\,Vdp = 0$$

$$-\frac{15}{17}\frac{dV}{V} = \frac{dp}{p}$$

$$\frac{p}{p_1} = \left(\frac{V_1}{V}\right)^{17/15} = 2^{17/15}$$

$$p = 2^{(\ldots)/3} \, p_1$$

I 1)

$$C = \frac{dU}{dT} + p\frac{dV}{dT} =$$

$$= \frac{\partial U}{\partial T} + \left(\underbrace{\frac{\partial U}{\partial V}}_{0} + p\right)\frac{dV}{dT}$$

$$U = \frac{i}{2}RT$$

$$C = \frac{i}{2}R + p\frac{dV}{dT}$$

$$C_1 = C_V + \frac{RT}{V}\frac{\Delta V_1}{\Delta T_1}$$

$$C_2 = C_V + \frac{RT}{V}\frac{\Delta V_2}{\Delta T_2}$$

$$\Delta C = \frac{\Delta}{V}\left(\frac{\Delta V_2}{\Delta T_2} - \frac{\Delta V_1}{\Delta T_1}\right) =$$

$$= \frac{\frac{3}{2} R T_0}{2V_0}\left(\frac{+V_0}{-\frac{1}{2}T_0} - \frac{V_0}{\frac{1}{2}T_0}\right) =$$

$$= \boxed{-3R}$$

$\underline{1.75}$ $He : H_2 = 2 : 1$

$$m_{He} : m_{H_2} = \nu_{He}\mu_{He} : \nu_{H_2}\mu_{H_2} =$$

$$= 2\nu_{He} : \nu_{H_2} = 2 : 1$$

$$\nu_{He} = \nu_{H_2}$$

1) $V = const$

$$c_V dT = \sum_n \frac{i_n}{2}\nu_n R dT$$

$$c_v = \sum_n \frac{i_n}{2} \nu_n R$$

2) $p = \text{const}$

$$c_p \, dT = \sum_n \frac{i_n}{2} \nu_n R\, dT + \nu_n R\, dT$$

$$c_p = \sum \left(\frac{i_n}{2} + 1\right) \nu_n R$$

$$\gamma = \frac{c_p}{c_v} = \frac{\sum \left(\frac{i_n}{2} + 1\right) \nu_n}{\sum \frac{i_n}{2} \nu_n}$$

$$\gamma - 1 = \frac{2 \sum \nu_n}{\sum i_n \nu_n}$$

$$\frac{1}{\gamma - 1} = \frac{\sum \frac{i_n}{2} \nu_n}{\sum \nu_n} = \sum \frac{1}{\gamma_n - 1} \frac{\nu_n}{\nu}$$

$$\frac{1}{\gamma-1}=\frac{1}{2}\left(\frac{1}{\frac{5}{3}-1}+\frac{1}{\frac{7}{5}-1}\right)=$$

$$=\frac{1}{2}\left(\frac{3}{2}+\frac{5}{2}\right)=2\Rightarrow\gamma=\frac{3}{2}$$

$$p_1^{1-\gamma}T_1^{\gamma}=p_2^{1-\gamma}T_2^{\gamma}$$

$$T_2=T_1\left(\frac{p_1}{p_2}\right)^{\frac{1-\gamma}{\gamma}}=$$

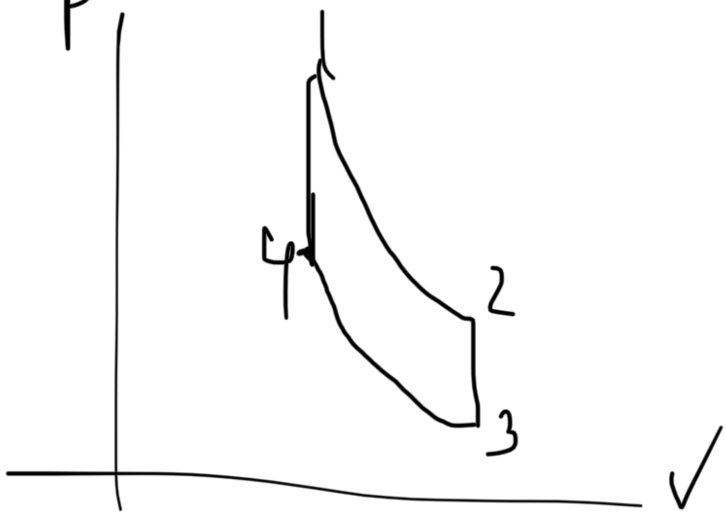
$$=T_1\cdot(8)^{-\frac{1}{3}}=T_1/2=\boxed{300K}$$

1.83

$$C_p m\,dT=(1-\alpha)\frac{7}{2}\nu R\,dT+$$
$$+2\alpha\cdot\frac{5}{2}\nu R\,dT$$

$$\alpha = \frac{4A\,c_p - 7R}{3R} \simeq 0{,}516$$

3.52)



$$A_{12} = -\int_1^2 dU_{12} = -\frac{3}{2}R\int_1^2 dT = \frac{3}{2}R(T_1 - T_2)$$

$$A_{34} = \frac{3}{2}R(T_3 - T_4)$$

$$A = A_{12} + \cancel{A_{23}}^{0} + A_{34} + \cancel{A_{41}}^{0} =$$

$$= \frac{3}{2}R(T_1 + T_3 - (T_2 + T_4))$$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$T_1 V_1^{\gamma-1} = T_2 V_3^{\gamma-1}$$

$$T_4 V_1^{\gamma-1} = T_3 V_3^{\gamma-1}$$

$$\frac{T_1}{T_4} = \frac{T_2}{T_3}$$

$$T_1 T_3 = T_2 T_4 = \text{const}$$

Хоту: $T_2 + T_4 \to \min$

$$\Leftrightarrow T_2 = T_4 = \sqrt{T_1 T_3}$$

$$\Rightarrow A = \frac{3}{2} R \left(T_1 + T_3 - 2\sqrt{T_1 T_3} \right)$$

3.47) $T_{\text{н}} = 299\,K \quad T_{\text{к}} = 294\,K$

$\Delta T_{\text{н}} = 5\,K$

$\frac{A_1}{A_0} - ?$

$$\eta = 1 - \frac{T_{\text{к}}}{T_{\text{н}}} = \frac{A}{Q_{\text{н}}}$$

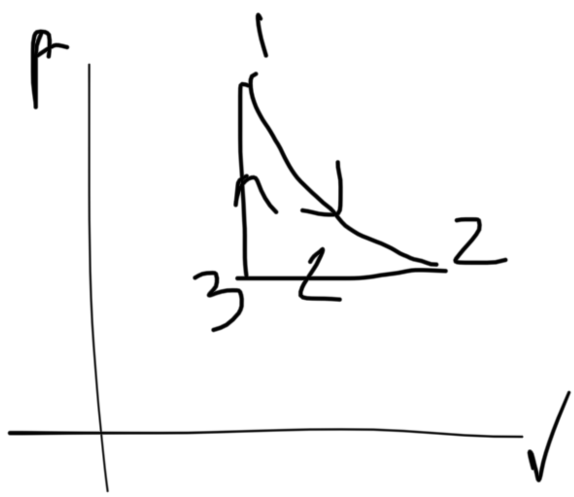
$$Q_{\text{н}} = \alpha (T_{\text{н}} - T_{\text{к}})$$

$$A = \alpha \frac{(T_{\text{н}} - T_{\text{к}})^2}{T_{\text{н}}}$$

$$\frac{A_1}{\ } = \left(T'_{\text{н}} - T_{\text{к}}\right)^2 \quad (10)^2 = (1.$$

$$A_0 = \left(\frac{q}{T_y - T_K}\right) = \left(\frac{\cdot}{5}\right) = \boxed{14}$$

$\boxed{4.15}$



$\eta - ?$

$$\Delta S_{max} = 0{,}2\, c_V$$

$$\Delta S = c_V \ln\frac{T}{T_0} + R\ln\frac{V}{V_0}$$

$$dS = \frac{1}{T} c_V dT + \frac{p\,dV}{T} =$$

$$= \frac{1}{T}\left[c_V \frac{p\,dV + V\,dp}{\nu R} + p\,dV\right] =$$

$$= \frac{1}{\nu R T}\left[c_p\, p\,dV + c_V V\,dp\right] =$$

$$= c_p \frac{dV}{V} + c_v \frac{dp}{p} =$$

$$c_v \left[\gamma \frac{dV}{V} + \frac{dp}{p} \right]$$

$$\Delta S / c_v = \gamma \ln \frac{V}{V_0} + \ln \frac{p}{p_0}$$

$$b = \Delta S_{max} / c_v = \gamma \ln \frac{V_2}{V_1} = \ln \frac{p_1}{p_2}$$

$$\eta = 1 - \frac{Q_x}{Q_H} = 1 - \frac{c_p p_2 \Delta V}{c_v V_1 \Delta p} =$$

$$1 - \gamma \frac{p_2 \Delta V}{V_1 \Delta p} = 1 - \gamma \frac{e^{b/\gamma} - 1}{e^{b} - 1} \simeq$$

$$\simeq \boxed{0{,}025}$$

$\boxed{4.73}$ $C_1 = \alpha T, \; C_2 = \beta\sqrt{T}$

$$C = \frac{dU}{dT} + p\frac{dV}{dT} =$$

$$= C_V + p\frac{dV}{dT} = \alpha T$$

$$(\alpha T - C_V)\, dT = p\, dV$$

$$A_{11} = \alpha\left(T_1'^2 - T_1^2\right) - C_V\left(T_1' - T_1\right)$$

$$Q_{11} = \alpha\left(T_1'^2 - T_1^2\right)$$

$$A_x = \frac{2}{3}\beta\left(T_1'^{3/2} - T_1^{3/2}\right) - C_V\left(T_1 - T_1'\right)$$

$$A = A_x + A_n = \alpha\left(T_1'^2\right) - \frac{2}{3}\beta T_1'^{3/2}$$

$$+ \underbrace{\frac{2}{3}\beta T_1^{3/2} - \alpha T_1^2}_{0}$$

$$A = \alpha T_1'^2 - \frac{2}{3}\beta T_1'^{3/2}$$

$$C\,dT = T\,dS$$

$$dS = \frac{C\,dT}{T}$$

$$S_1 = \alpha T$$

$$S_2 = -2\beta\sqrt{T}$$

$$\alpha\left(T_1' - T_1\right) = 2\beta\left(\sqrt{T_1'} - \sqrt{T_1}\right)$$

$$\alpha\left(\sqrt{T_1'} + \sqrt{T_1}\right) = 2\beta$$

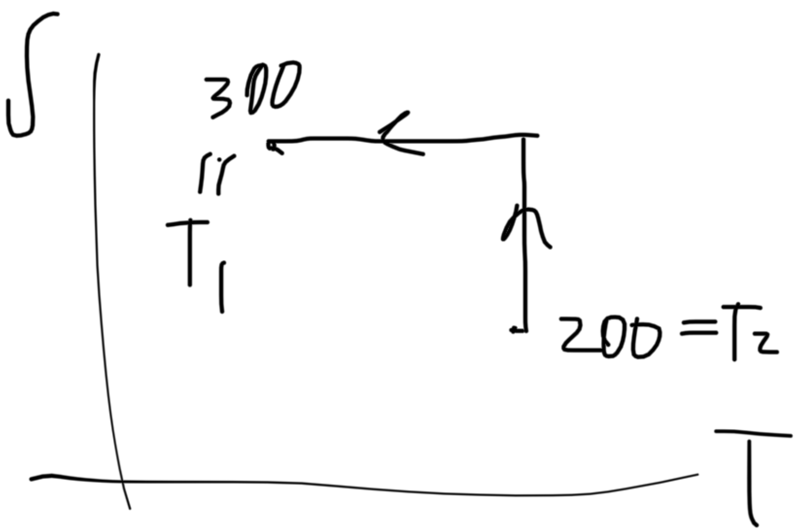
$$\sqrt{T_1'} + \sqrt{T_1} = 3\sqrt{T_1}$$

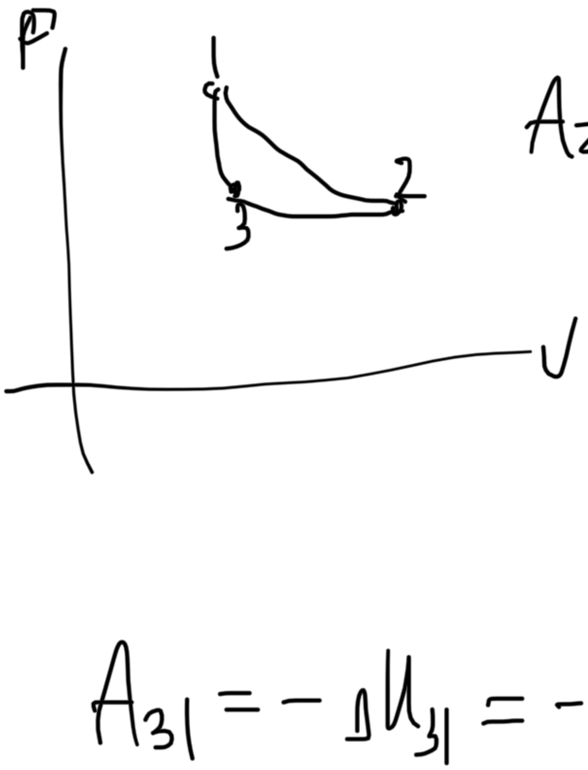
$$T_1' = 4T_1$$

$$\eta = \frac{A}{Q_n} = \frac{T_1'^2 - T_1^{1/2}\,T_1'^{3/2}}{T_1'^2 - T_1^2} =$$

$$= \frac{16 - 4\sqrt{4}}{15} \simeq 0{,}53$$

4.47





$$A_{23} = Q_{23} =$$

$$= T_2(S_3 - S_2) =$$

$$= T_2(S_1 - S_2)$$

$$A_{31} = -\Delta U_{31} = -\frac{3}{2}\nu R(T_1 - T_2)$$

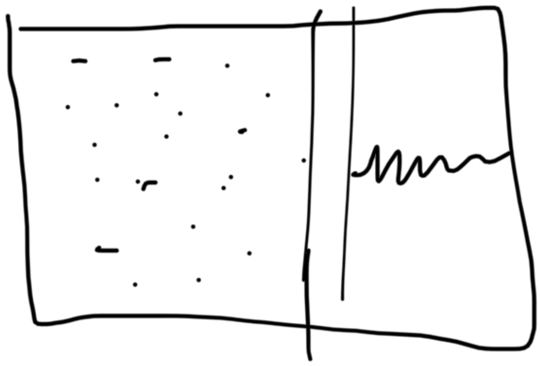
$$A = \frac{3}{2}\nu R(T_1 - T_2) + T_2(S_2 - S_1)$$

$$\Delta S = \frac{A - \frac{3}{2}\nu R\Delta T}{T_2} = \boxed{1{,}7\ \frac{\text{Дж}}{\text{К}}}$$

$\boxed{3}$

d=1 моль

N_2



$n=3$

$$p_0 V_0 = R T_0$$

$$p_1 V_1 = R T_1 = 3 p_0 V_1$$

$$p_1 S = kx = \frac{k \Delta V}{S}$$

$$k = \frac{3 p_0 S^2}{\Delta V}$$

$$\frac{T_1}{T_0} = 3 \frac{V_1}{V_0}$$

$$c_v (T_0 - T_1) = \frac{k x^2}{2} =$$

$$= \frac{K \Delta V^2}{2S^2} = \frac{3 p_0 \Delta V}{2}$$

$$T_0 - T_1 = \frac{1}{3} T_1 - T_0$$

$$2 T_0 = \frac{4}{3} T_1$$

$$\frac{T_1}{T_0} = \frac{3}{2}, \quad \frac{V_1}{V_0} = \frac{1}{2}$$

$$\Delta S = \frac{5}{2} R \ln \frac{T_1}{T_0} + R \ln \frac{V_1}{V_0} =$$

$$= 0{,}32\, R$$

5.32 $\quad \Psi = -\frac{RT}{2} \ln(A T^3 V^2) =$

$$= U - TS$$

$$d\psi = dU - TdS - SdT =$$

$$= -p\,dV - S\,dT$$

$$p = -\frac{\partial\psi}{\partial V} = \frac{RT}{V}$$

$$S = -\frac{\partial\psi}{\partial T} = \frac{R}{2}\ln(AT^3V^2)$$

$$+ \frac{R\cancel{T}}{2}\,\frac{3A\cancel{T^2}\cancel{V^2}}{A\cancel{T^3}\cancel{V^2}} =$$

$$= \frac{R}{2}\ln(AT^3V^2) + \frac{3R}{2}$$

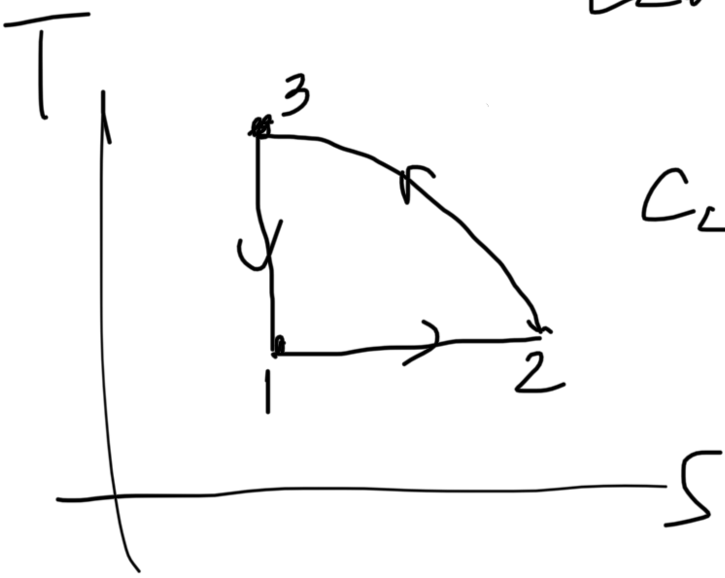
$$TdS = c_V\,dT + p\,dV =$$

$$= T\left[\frac{3R}{2}\frac{dT}{T} + R\frac{dV}{V}\right]$$

$$\Rightarrow \; C_v = \frac{3}{2}R, \quad \boxed{C_p = \frac{5}{2}R}$$

$\boxed{5.54}$

$$f = \alpha T\left[\frac{L}{L_0} - \left(\frac{L_0}{L}\right)^2\right]$$



$C_L = 1{,}2$ Дж/К

$Q - ?$

$$\delta Q = T\,dS = C_L\,dT + \delta A$$

$$\delta A = f\,dL$$

$$A = \alpha T_1 \left(\frac{L^2}{2L_0} + \frac{L_0^2}{L} - \frac{3}{2} L_0 \right)$$

$$Q_{12} = T_1 (S_2 - S_1)$$

$$A_{12} = \alpha T_1 L_0 \left(2 + \frac{1}{2} - \frac{3}{2} \right) =$$

$$= \alpha T_1 L_0$$

$$Q_{12} = \alpha T_1 L_0 \simeq -3{,}9 \text{ Dne}$$

$$\Delta S = \alpha L_0$$

$$T dS = C_L dT - \cancel{f dL}^{\,0}$$

$$\Delta S = C_L \ln \frac{T_3}{T_1}$$

$$T_3 = T_1 e^{\alpha L_0 / C_L}$$

$$S = c_L \ln\frac{T}{T_1} + \alpha\left[\frac{L^2}{2L_0} + \frac{L_0^2}{L}\right]\Bigg|_{2L_0}^{L}$$

$$= c_L \ln\frac{T}{T_1} + \alpha\left[\frac{L^2}{2L_0} + \frac{L_0^2}{L} - \frac{5}{2}L_0\right]$$

$$= c_L \ln\frac{T}{T_1} + \frac{\alpha L_0}{2}\left[\left(\frac{L}{L_0}\right)^2 + 2\frac{L_0}{L} - 5\right]$$

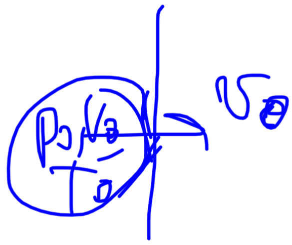
$$L = \text{const} \Rightarrow dL = 0$$

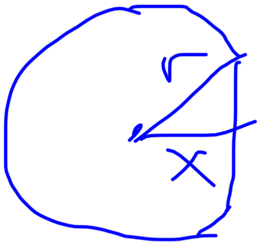
$$Q_{23} = c_L(T_3 - T_1) =$$

$$= c_L T_1\left(e^{\alpha L_0/c_L} - 1\right) \simeq 3{,}96\,\text{Дж}$$

4 неделя

5.63 $\qquad \tau - ?$





$$2mv_0 = \Delta p = F\tau$$

$$m\ddot{x} = -p_0 S =$$

$$= -p_0 \pi (r^2 - x^2)$$

$$y = r - x \ll 1$$

$$m\ddot{y} + 2p_0 \pi r y = 0$$

$$y = y_{max} \sin \omega t$$

$$\omega = \sqrt{\frac{2 p_0 \pi r}{m}}$$

$$T \simeq 2\pi/\omega \simeq \sqrt{\frac{2\pi m}{p_0 r}} \simeq 10^{-2} c$$

5.63

$$\frac{\Delta V}{V} = 0{,}01 \qquad \frac{\Delta T}{T} = 0{,}028$$

$$\beta_T = V_0 \left|\frac{\partial p}{\partial V}\right|_T \qquad -?$$

$$\alpha = \frac{1}{V_0}\left(\frac{\partial V}{\partial T}\right) = 5{,}7 \cdot 10^{-5}\, K^{-1}$$

$$C_V = 0{,}23\ \text{J}/\text{g} \cdot K\,,\ \rho = 10{,}5\ \text{g}/\text{cm}^3$$

$$\beta_S = \gamma \beta_T = V_0 \left(\frac{\partial p}{\partial V}\right)_S$$

$$G = pV - TS + U$$

$$dG = p\,dV + V\,dp - T\,dS - S\,dT =$$

$$= V\,dp - S\,dT$$

$$-\left(\frac{\partial S}{\partial p}\right)_T = \left(\frac{\partial V}{\partial T}\right)_p$$

$$\beta_S = V_0 \left(\frac{\partial p}{\partial V}\right)_S \left(\frac{\partial S}{\partial p}\right)_T \left(\frac{\partial V}{\partial S}\right)_p$$

$$\left(-\frac{\partial T}{\partial V}\right)_p \left(\frac{\partial p}{\partial T}\right)_S =$$

$$= V_0 \left(\frac{\partial T}{\partial V}\right)_p \left(\frac{\partial p}{\partial T}\right)_S$$

$$\beta_S = V_0 \left(\frac{\partial p}{\partial V}\right)_S = V_0 \left(\frac{\partial T}{\partial V}\right)_S \left(\frac{\partial S}{\partial V}\right)_p \ominus$$

$$\left(\frac{\partial T}{\partial p}\right)_S = \left(\frac{\partial V}{\partial S}\right)_p$$

$$\ominus \quad \frac{V}{\Delta V}\frac{\Delta T}{T}\left(\frac{T\partial S}{\partial V}\right)_p =$$

$$= \frac{V}{\Delta V}\frac{\Delta T}{T}\left(\frac{C_p\,\partial T}{\partial V}\right)_p =$$

$$= \frac{1}{\Delta V}\frac{\Delta T}{T}\frac{C_p}{\alpha} = \frac{V}{\Delta V}\frac{\Delta T}{T}\frac{\rho\,\tilde{C}_p}{\alpha}$$

$$\beta_T = \frac{1}{\gamma}\beta_S = \frac{V}{\Delta V}\frac{\Delta T}{T}\frac{\rho c_v}{\alpha}$$

$$\beta_T \to \frac{1}{\beta_T} \Rightarrow \frac{\alpha \, \Delta V/V}{\rho C_v \frac{\Delta T}{T}} \simeq 8{,}43 \cdot 10^{-12}\,\mathrm{Pa}^{-1}$$

T.4

$$F = U - TS$$

$$dF = -SdT - pdV$$

$$F = F_0 - \beta V^{\frac{2}{3}} T^2$$

$$c_p - c_v = ? \quad (V, T)$$

$$C_p = \left(\frac{\partial U}{\partial T}\right)_p + p\left(\frac{\partial V}{\partial T}\right)_p$$

$$C_v = \left(\frac{\partial U}{\partial T}\right)_v$$

$$\left(\frac{\partial F}{\partial T}\right) = -S = -2\beta V^{\frac{2}{3}} T$$

$$\left(\frac{\partial F}{\partial V}\right) = -p = -\frac{2}{3}\beta V^{-\frac{1}{3}} T^2$$

$$Sp^2 = \frac{8}{9}\beta^3 T^5$$

$$\left(\frac{\partial V}{\partial T}\right)_p = -\left(\frac{\partial S}{\partial p}\right)_T =$$

$$= -\left(\frac{\frac{4}{3}\beta V^{-\frac{1}{3}} \alpha V \cdot T}{-\frac{2}{9}\beta V^{-\frac{4}{3}} \alpha V\, T^2}\right)_T =$$

$$= 6\,\frac{V}{T}$$

$$\left(\frac{\partial U}{\partial T}\right)_p = \left(\frac{T\,\partial S}{\partial T}\right)_p - \left(\frac{p\,\partial V}{\partial T}\right)_p =$$

$$= -\frac{6pV}{T} + T\left(\frac{\partial S}{\partial T}\right)_p = -\frac{6pV}{T} + 10T\beta V^{\frac{2}{3}}$$

$$\left(\frac{\partial U}{\partial T}\right)_V = T\left(\frac{\partial S}{\partial T}\right)_V = 2\beta V^{\frac{2}{3}} T$$

$$\left(\frac{\partial S}{\partial T}\right)_p = \frac{5}{p^2}\,\frac{8}{9}\,\beta^3 T^4 =$$

$$= \frac{\cancel{40}^{10}\,\beta^3\,\cancel{T^4}}{\cancel{9}\cdot\frac{\cancel{4}}{\cancel{9}}\,\cancel{\beta^2}\,V^{-2/3}\,\cancel{T^4}} = 10\beta V^{2/3}$$

$$C_p - C_V = 10\beta T V^{2/3} - \frac{6pV}{T} +$$

$$+ \frac{6pV}{T} - 2\beta T V^{2/3}$$

$$= \boxed{8\beta T V^{2/3}}$$

12.9

$$\frac{1}{T}\left(\frac{\partial u}{\partial V}\right)_T = \left(\frac{\partial p}{\partial T}\right)_V - \frac{p}{T}$$

$$\frac{1}{T}\left(\frac{\partial u}{\partial \Pi}\right)_T = -\left(\frac{\partial \sigma}{\partial T}\right)_\Pi + \frac{\sigma}{T}$$

$$u = \left(\sigma - T\frac{d\sigma}{dT}\right)\Pi$$

$$\Pi = 4\pi r^2$$

$$\Delta T = \frac{2u}{J C_v} = \frac{8\pi r^2\left(\sigma - T\frac{d\sigma}{dT}\right)}{J C_v}$$

$$= \frac{16\pi r^2\left(\sigma - T\frac{d\sigma}{dT}\right)}{5JR} \simeq 3\cdot 10^{-3}\,K$$

12.38

$$\begin{cases} p_0 = \dfrac{4\sigma}{r_0} \\ p_1 = \dfrac{4\sigma}{r_1} \end{cases} \qquad \frac{p_0}{p_1} = \frac{r_1}{r_0}$$

$$p_0 \frac{4}{3}\pi r_0^3 = \nu RT$$

$$p_1 \frac{4}{3}\pi r_1^3 = 2\nu RT$$

$$r_1 = \sqrt{2}\, r_0$$

$$p_0 = \sqrt{2}\, p_1$$

$$T dS = c_v 2\nu dT + p dV$$

$$S = 2\nu c_v \cancel{\ln \frac{T_1}{T_0}} \to 0 + 2\nu R \ln \frac{V_1}{V_0} =$$

$$= \frac{\frac{4\sigma}{\cancel{\sqrt{2}} r_0} \frac{4}{3} \pi \cancel{\sqrt{2}^3}^{2} r_0^3}{T} \cdot \frac{\cancel{3}}{\cancel{2}} \ln 2$$

$$= \frac{16\pi\sigma r_0^2}{T}\ln 2 \simeq 28\,\frac{\text{эрг}}{K}$$

Неделя 5

11.74

$$S_ж = \frac{RT}{\theta} \qquad \theta \simeq 0{,}46\,K, \quad p = 30\ \text{атм}$$

$$S_{тв} = 0{,}7R$$

$$T_1 = 0{,}25\,K, \quad p_1 = 29\ \text{атм}$$

$$T = 0{,}1\,K \qquad p = ?$$

$$\Delta V = 1{,}25\ \text{см}^3$$

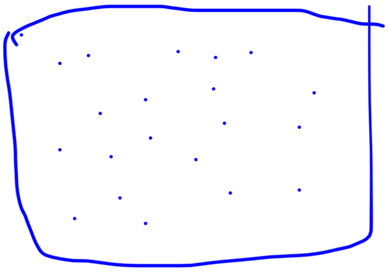
$$\frac{dp}{dT} = \frac{S_ж - S_{тв}}{\Delta V}$$

$$p - p_1 = \frac{1}{\Delta V}\left(\frac{R}{2\theta}\left(T^2 - T_1^2\right) - 0{,}7R\left(T - T_1\right)\right)$$

$$p \simeq 32\ \text{атм}$$

11.78

$T - ?$ $\to 273\,K$ T_1



$V = 10\,л$

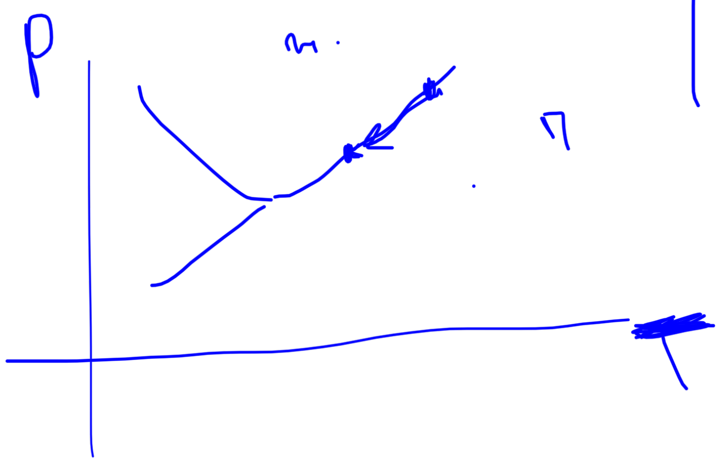
$m'_в = 67\,г$

$\Lambda = 40{,}7\ кДж/моль$

$$\frac{dp}{dT} = \frac{\Lambda m'_в}{\mu T (V_2 - V_1)} \approx \frac{\Lambda \nu}{V T}$$

$$V = \frac{\nu R T}{p}$$

$$\frac{dp}{dT} = \frac{\Lambda p}{R T^2}$$

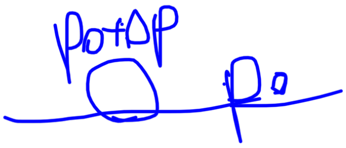


$$p = p_0 \exp\left(\frac{\Lambda}{R}\left(\frac{1}{T_0} - \frac{1}{T}\right)\right)$$

$$\frac{\Lambda m'_в}{\mu V} = p_0 \frac{\Lambda}{R T^2} \exp\left(\frac{\Lambda}{R}\left(\frac{1}{T_0} - \frac{1}{T}\right)\right)$$

$$\Rightarrow T = \dots$$

12.48



$$\Delta p = \frac{2\sigma}{r} \simeq 10^{9}\ \frac{\text{дин}}{\text{см}^2}$$

$$= 10^{4}\ \frac{\text{Н}}{10^{-4}\ \text{м}^2}$$

$$= 10^{8}\ \text{Па}$$

$$p_0 V = \nu R T$$

$$p_0 = \frac{\rho}{\mu} R T = 1{,}7 \cdot 10^{8}\ \text{Па}$$

$$\frac{p_0 + \Delta p}{p_0} \simeq 1{,}8$$

Нед. 6

6.41

$$T = \text{const} = T_0 \qquad V_0 \to V_0/2 \to 2V_0$$

$$a, b, C_V$$

$$\Delta S_1 = R \ln\left(\frac{V_0/2 - b}{V_0 - b}\right)$$

$$\delta Q = T\,dS = dU = C_V\,dT + \frac{a\,dV}{V^2}$$

$$dS = \frac{a\,dV}{T V^2}$$

$$\Delta S_2 = \frac{a}{T_0}\left(\frac{2}{V_0} - \frac{1}{2b}\right) \simeq \frac{3a}{2T_0V_0}$$

$$\Delta S_1 + \Delta S_2 = \frac{3a}{2T_0V_0} - R\ln\left(2 + \frac{b}{\frac{V_0}{2} - b}\right)$$

$$\simeq \frac{3a}{2T_0V_0} - R\ln 2 - R\frac{b}{V_0 - b}$$

6.73 $\quad \frac{T_{кр}}{T} = 0{,}4 \qquad \frac{V_{кр}}{V} = 0{,}09$

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

$$-\frac{2a}{V^3}\frac{\partial V}{\partial T}(V - b) + \frac{\partial V}{\partial T}\left(p + \frac{a}{V^2}\right) = R$$

$$-2a\left(\frac{V_{кр}}{V}\right)^2 \frac{1}{V_{кр}^2}\,\alpha\left(\frac{V}{V_{кр}}V_{кр} - b\right)$$

$$+\alpha V \frac{RT}{V - b} = R$$

$$\Rightarrow \alpha = \ldots$$

J-T :

$$\frac{\Delta T}{\Delta p} \simeq \frac{2a}{RT\,C_p} - \frac{b}{C_p}$$

<u>6.87.</u> $T_0 = 3T_{kp}$, N_2, ΔT.

$V \uparrow$ (gong.)

$V_0 - ?$ $T - ?$, $T_{kp} = 126K$, $V_{kp} = 1\mu \frac{cm^3}{mol}$

$$H = U + pV = const$$

$$c_V T_0 - \frac{a}{V_0} + p_0 V_0 = c_V T + \underset{\substack{\parallel \\ RT}}{pV}$$

$$\left(p_0 + \frac{a}{V_0^2}\right)(V_0 - b) = RT_0$$

$$p_0 = \frac{RT_0}{V_0 - b} - \frac{a}{V_0^2}$$

$$c_V T_0 - \frac{2a}{V_0} + \frac{V_0 RT_0}{V_0 - b} = (c_V + R)T$$

$$(c_V + R)\Delta T = \frac{2a}{V_0} - \frac{RT_0 b}{V_0 - b}$$

$$\Delta T = \frac{\frac{2a}{V_0} - \frac{bRT_0}{V_0 - b}}{C_V + R}$$

$$\Delta T' = 0 \Rightarrow V_0 = V_{kp} = 114\ cm^3/mol$$

$$T = T_{kp} - \frac{\frac{2a}{3b} - \frac{\cancel{8}^{4}a}{\cancel{27}\,\cancel{2}b}}{\frac{7}{2}R} \simeq 351K$$

$$\frac{\cancel{14}^{2} \cdot 2}{27 \cdot \cancel{7}}$$

2.20

$$p_0 = 0{,}3\ atm$$

$$pV^{\gamma} = const \qquad p^{1-\gamma}T^{\gamma} = const$$

$$i + \frac{v^2}{2} = const$$

$$\Delta|I| = \frac{1}{2}M^2C^2 = \frac{1}{2}M^2\frac{\gamma RT}{\mu}$$

$$\simeq C_p\Delta T$$

$$p = p_b \left(\frac{T}{T_b}\right)^{\frac{\gamma}{\gamma-1}} = p_b\left(1+\frac{\Delta T}{T}\right)^{\frac{\gamma}{\gamma-1}}$$

$$\frac{\Delta T}{T} = \frac{R}{2c_v} M^2 = \frac{\gamma-1}{2} M^2$$

$$p = p_b \left(1+\frac{\gamma-1}{2}M^2\right)^{\frac{\gamma}{\gamma-1}} \simeq 0{,}6 \text{ атм.}$$