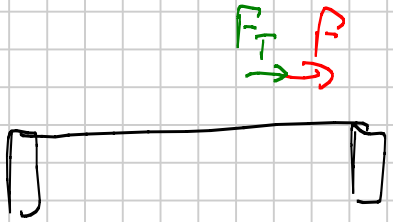
Einheit 11:

11.1.)



$\sigma = \frac{F_T}{A} = E \cdot \varepsilon = E \cdot \frac{\Delta l}{l}$

$\Delta l = l_0 (1 + \alpha \Delta T)$

$E \cdot \frac{\Delta l}{l} = \frac{F_T}{A}$

$F_T = E \cdot \frac{\Delta l}{l} \cdot A$

$F_T = E \cdot \frac{l \cdot \alpha \cdot \Delta T}{l} A$

$\phi d = 1\,mm = 10^{-1}\,cm$

$F = 10\,kp$

$T_1 = 28°C$

$T_2 = -12°C$

$\alpha_{St} = 12 \cdot 10^{-6}\,grd^{-1}$

$E_{St} = 2{,}2 \cdot 10^6\,kp/cm^{-2}$

$A = \frac{d^2 \pi}{4}$

$F_T = 2{,}2 \cdot 10^6 \cdot 12 \cdot 10^{-6} \cdot (28 - (-12)) \cdot \frac{(10^{-1})^2 \pi}{4}$

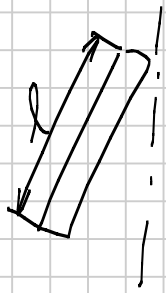
$F_T = 8{,}29\,kp$

$F_{ges} = F + F_T$

$F_{ges} = 10 + 8{,}29$

$F_{ges} = 18{,}29\,kp$

11.2.)



$$\tau = 2\pi\sqrt{\frac{I}{mgs}}$$

$$\frac{\tau_1}{\tau_2} = \frac{2\pi\sqrt{\frac{I}{mgs_1}}}{2\pi\sqrt{\frac{I}{mgs_2}}} \qquad | s_i = \frac{l_i}{2}$$

$$\frac{\tau_1^2}{\tau_2^2} = \frac{l_2}{l_1} \qquad | l_2 = l_1(1+\alpha\Delta T)$$

$$\frac{\tau_1^2}{\tau_2^2} = \frac{l_1(1+\alpha\Delta T)}{l_1}$$

$$\tau_2 = \sqrt{\tau_1^2 \cdot (1+\alpha\Delta T)}$$

$$\tau_2 = \sqrt{1 \cdot (1+12\cdot 10^{-6}\cdot(25-10))}$$

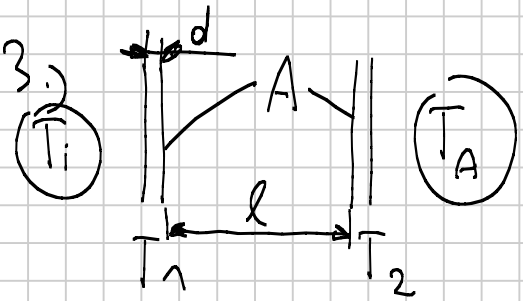
$$\underline{\tau_2 = 1{,}000142\,s}$$

falscher Gang: $3600 \cdot 24 \cdot \Delta\tau$

$3600 \cdot 24 \cdot (1{,}000142 - 1)$

falscher Gang = $\underline{12{,}31\,s/d}$

11.3.)



$T_i = 20°C$

$T_A = -10°C$

$A = 1m^2 = 10^4 cm^2$

$t = 24h = 86400s$

$d = 20cm$

$\lambda_w = 0{,}003\ cal\ °C^{-1} s^{-1} cm^{-1}$

$\alpha = 0{,}0002\ cal \cdot C^{-1} s^{-1} \cdot cm^{-2}$

$\frac{Q}{t} = \lambda \frac{A}{d} (T_1 - T_2)$ ... Leitung in Wand

$\frac{Q}{t} = \alpha A (T_i - T_1)$ ... Raum zu Innenwand

$\frac{Q}{t} = \alpha A (T_2 - T_A)$ ... Umwelt zu Aussenmauer

$$Q = \left(\frac{1}{\frac{1}{\alpha} + \frac{l}{\lambda} + \frac{1}{\alpha}}\right) \cdot A (T_i - T_A) \cdot t \quad \text{... Übergang}$$

$$Q = \left(\frac{2}{0{,}0002} + \frac{20}{0{,}003}\right)^{-1} \cdot 10^4 \ (20 - (-10)) \cdot 86400$$

$$\underline{Q = 1.555.200\ cal}$$

$$T_1 = T_i - \frac{Q}{t \alpha A} = 20 - \frac{1555200}{86400\ 0{,}0002 \cdot 10^4} = \underline{11°C}$$

$$T_2 = \frac{Q}{t \alpha A} + T_A = \frac{1555200}{86400\ 0{,}0002 \cdot 10^4} + (-10) = \underline{-1°C}$$

11.4.) 1: H_2 0,7 bar
2: CH_4 2 bar
3: CO 1,3 bar

$m_{ges} = 1\,g$

$p_{ges} = \sum p_i = 4$ bar

$p = nkT$ | T = const.
k = Boltzman const. für 1 Mol

$p \approx n$ für 1 Mol

1 Mol H_2 = $2 \cdot 1{,}0079\,g$
1 Mol CH_4 = $1 \cdot 12{,}011\,g + 4 \cdot 1{,}0079\,g$
1 Mol CO = $1 \cdot 12{,}011\,g + 1 \cdot 15{,}999\,g$

$0{,}7 \cdot 2{,}0158\,g = 1{,}41106\,g$
$2 \cdot 16{,}0426\,g = 32{,}0852\,g$
$1{,}3 \cdot 28{,}01\,g = 36{,}413\,g$
$\sum = 69{,}90926\,g$

$1\,g\ Gas = \frac{m_i}{69{,}90926}$

$m_{H_2} = 0{,}02\,g$ $\quad m_{CO} = 0{,}521\,g$

$m_{CH_4} = 0{,}459\,g$

11.6) $V/h = 880\ m^3$

$T = 62°C = 273{,}15 + 62\ °K$

$p = 1\ bar$

$pV = \upsilon RT$

$\upsilon = \frac{pV}{RT} \quad / \upsilon = \frac{m}{m_A} \quad / m_A = A_r \cdot 10^{-3}$

$m = \frac{pV \cdot A_r \cdot 10^{-3}}{R \cdot T} \quad / R = 8{,}314\ \frac{J}{mol \cdot K}$

$A_r\ Luft = 28{,}96\ \frac{g}{mol}$

$m = \frac{1 \cdot 880 \cdot 28{,}96 \cdot 10^{-3}}{8{,}314 \cdot (273{,}15 + 62)}$

$m = 0{,}009196\ kg/h$