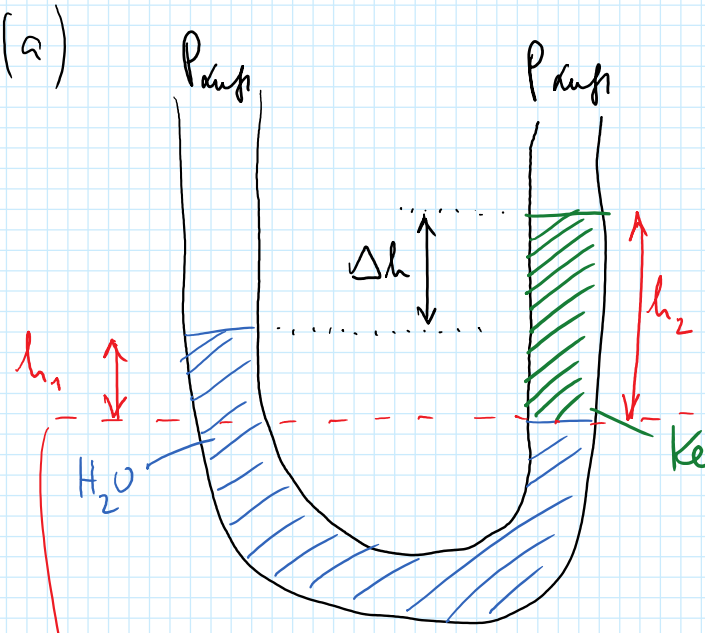
17 U-Rohr

(a)



$A = 80\ mm^2$

$\rho_w = 1000\ \frac{kg}{m^3}$

$V_K = 30{,}0\ cm^3$

$\rho_K = 670\ \frac{kg}{m^3}$

$\Delta h = h_2 - h_1$

Gleichgewicht: $p_{links} = p_{rechts}$

$$\cancel{p_{Umg}} + \frac{F_{links}}{A} = \cancel{p_{Umg}} + \frac{F_{rechts}}{A}$$

$$F_{links} = F_{rechts}$$

$$m_{links} \cdot g = m_{rechts} \cdot g$$

$$\boxed{m_{links} = m_{rechts}}$$

$\rho = \frac{m}{V}$

$m = \rho \cdot V = \rho \cdot A \cdot h$

$$\rho_w \cdot A \cdot h_1 = \rho_K \cdot A \cdot h_2$$

$$h_1 = h_2 \frac{\rho_K}{\rho_w}$$

$V_K = 30{,}0\ cm^3 = 30\,000\ mm^3$

$A = 80\ mm^2$

$$V_K = h_2 \cdot A$$

$$h_2 = \frac{V_K}{A} = \frac{30\,000\ mm^3}{80\ mm^2}$$

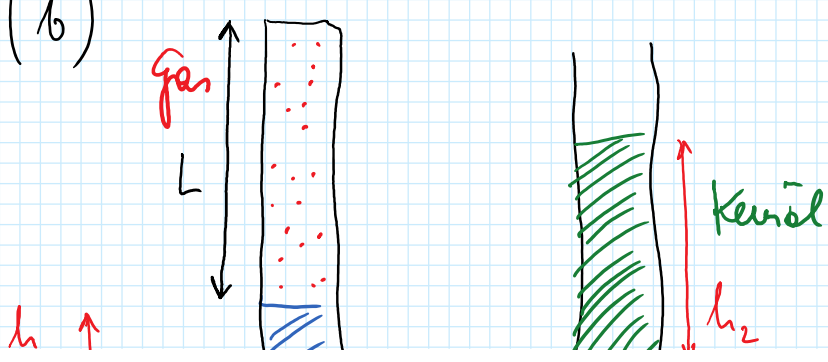
$$h_2 = 375\ mm$$

$$h_1 = h_2 \frac{\rho_K}{\rho_w} = 375\ mm \cdot \frac{670\ kg/m^3}{1000\ kg/m^3} = 251{,}25\ mm$$

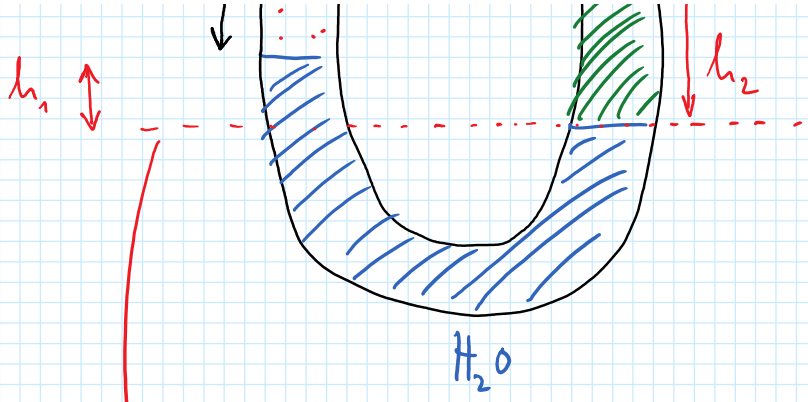
$$\Delta h = h_2 - h_1 = 123{,}75\ mm$$

$$\Delta h = 12\ cm$$

(b)



$L = 43{,}0\ mm$



Gleichgewicht: $p_{links} = p_{rechts}$

$$p_{Wasser} + p_{Gas} = p_{Kerosin} + p_{Luft}$$

$$p_W + p_G = p_K + p_L$$

$$p_W = \frac{m_W \cdot g}{A} = \frac{\rho_W A h_1 g}{A}$$

$$p_W = \rho_W h_1 g$$

aus (a)

$$p_K = \rho_K \cdot h_2 \cdot g = 670 \frac{kg}{m^3} \cdot 0{,}375\,m \cdot 9{,}81 \frac{m}{s^2}$$

$$p_K = 2464{,}7625 \frac{kg}{m\,s^2} = 2464{,}7625\ Pa$$

$$p_L = 1{,}01325 \cdot 10^5\ Pa = 101325\ Pa$$

$$p_G = \frac{nRT}{V}$$

$$n = 1{,}380 \cdot 10^{-4}\ mol$$

$$T = 22{,}5^\circ C = 295{,}65\ K$$

$$V = 43{,}0\ mm \cdot 80\ mm^2$$

$$V = 3{,}44 \cdot 10^{-6}\ m^3$$

$$p_G = \frac{1{,}38 \cdot 10^{-4}\ \text{mol} \cdot 8{,}31446\ \frac{J}{\text{mol K}} \cdot 295{,}65\ K}{3{,}44 \cdot 10^{-6}\ m^3}$$

$$p_G = 98612{,}638\ \frac{J}{m^3} \qquad \frac{J}{m^3} = \frac{N\,m}{m^3} = \frac{N}{m^2} = Pa$$

$$p_G = 98612{,}638\ Pa$$

$$\rho_W h_1 g + p_G = p_K + p_L$$

$$h_1 = \frac{1}{\rho_W g}\left(p_K + p_L - p_G\right)$$

$$h_1 = \frac{1}{1000\ \frac{kg}{m^3} \cdot 9{,}81\ \frac{m}{s^2}}\left(2464{,}7625 + 101325 - 98612{,}638\right) Pa$$

$$h_1 = 0{,}52774\ \frac{\frac{kg}{m\,s^2}}{\frac{kg}{m^2 s^2}} = 0{,}52774\ m$$

$$\Delta h = h_2 - h_1 = -152{,}74\ mm$$

$$\Delta h = -15\ cm$$

(Flüssigkeit steht links als rechts)

(18) Rösung

$$m = 0{,}5\ g$$

$m_{Ne} = 0{,}5\ g$

$m_{Ar} = 0{,}27\ g$

$m_{Co} = 0{,}125\ g \longrightarrow p_{Co} = 2{,}65\ Pa$

(a) $n_{ges} = ?$

$$n = \frac{m}{M_m}$$

$$n_{ges} = \sum n_i = \frac{0{,}5\ g}{20{,}180\ \frac{g}{mol}} + \frac{0{,}27\ g}{39{,}948\ \frac{g}{mol}} + \frac{0{,}125\ g}{28{,}01\ \frac{g}{mol}}$$

$n_{ges} = 0{,}0359985\ mol$

$n_{ges} = 36{,}0\ mmol$

(b) $p_{ges} = ?$

$$x_i = \frac{n_i}{n_{ges}} = \frac{p_i}{p_{ges}} \longrightarrow p_i = x_i \cdot p_{ges}$$

$$n_{Co} = \frac{0{,}125\ g}{28{,}01\ \frac{g}{mol}} = 0{,}0044627\ mol$$

$$x_{co} = 0{,}123969$$

$$p_{ges} = \frac{p_{co}}{x_{co}} = 21{,}376312 \text{ Pa}$$

$$p_{ges} = 21{,}4 \text{ Pa}$$

(c) $pV = nRT$

$$V = \frac{n_{ges} R T}{p_{ges}}$$

$$V = \frac{0{,}0359985 \text{ mol} \cdot 8{,}31446 \frac{\text{kg m}^2}{\text{s}^2 \text{ mol K}} \cdot 325 \text{ K}}{21{,}376312 \frac{\text{kg}}{\text{m s}^2}}$$

$$V = 4{,}550604 \text{ m}^3$$

$$V = 4{,}55 \text{ m}^3$$

19 Arbeit

S_1 : $V_1 = 325 \text{ cm}^3$

$p_1 = 125 \text{ mbar}$

$p = \text{const}$

$p_1 = 125$ mbar

$p = \text{const}$ ↓

S_2 : $V_2 = 2V_1 = 650\ cm^3$

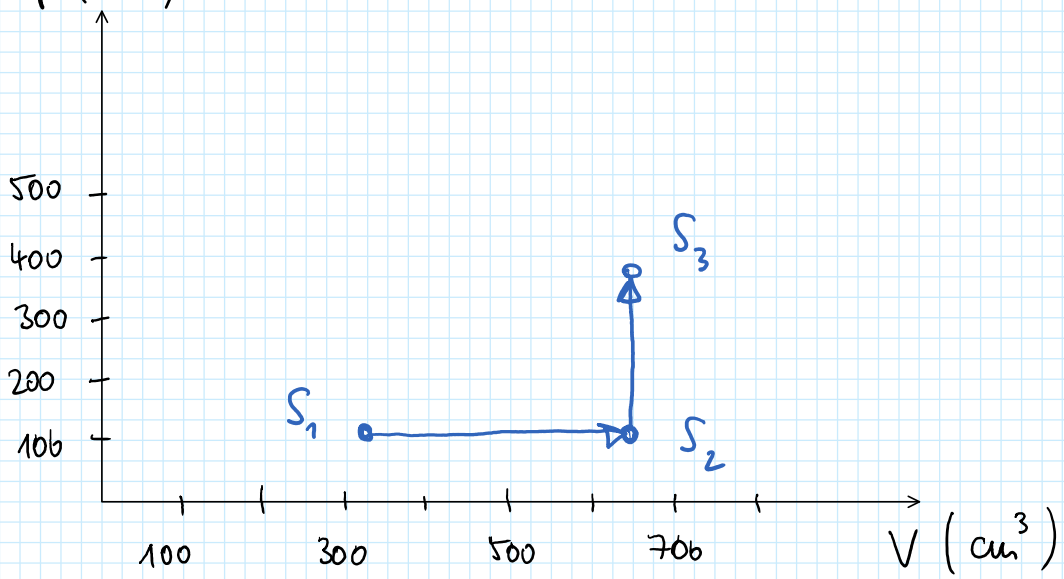
$p_2 = p_1 = 125$ mbar

$V = \text{const}$ ↓

S_3 : $V_3 = V_2 = 650\ cm^3$

$p_3 = 3p_2 = 375$ mbar

(a)



(b) $W_{ges} = ?$ $\quad W(S_2 \to S_3) = 0$ weil $dV = 0$

$W_1 = W(S \to S_1)$ $\quad W_1 = -\int p\,dV$

$W_{ges} = W(S_1 \to S_2)$ $\qquad W = -\int p\,dV$

$W_{ges} = -p_1 (V_2 - V_1)$ $\qquad$ (weil $p = \text{const}$)

$= -125\ \text{mbar}\ (650 - 325)\ \text{cm}^3$

$= -125 \cdot 10^{-3}\ \text{bar} \cdot 325\ \text{cm}^3$

$$\begin{cases} 1\ \text{bar} = 10^5\ \text{Pa} = 10^5\ \frac{\text{kg}}{\text{m s}^2} \\ 1\ \text{cm}^3 = 10^{-6}\ \text{m}^3 \end{cases}$$

$W_{ges} = -125 \cdot 10^{-3} \cdot 10^5\ \frac{\text{kg}}{\text{m s}^2} \cdot 325 \cdot 10^{-6}\ \text{m}^3$

$W_{ges} = -4{,}0625\ \frac{\text{kg m}^2}{\text{s}^2}$

$\frac{\text{kg m}^2}{\text{s}^2} \to \text{J}$

$W_{ges} = -4{,}06\ \text{J}$