WBa, 14.12.2018

1. $T_1 = 18°C = 291.15K$
$T_2 = 23°C = 296.15K$
} p und n bleiben gleich

$$\left.\begin{aligned} pV_2 &= nRT_2 \\ pV_1 &= nRT_1 \end{aligned}\right\} \Rightarrow \frac{V_2}{V_1} = \frac{T_2}{T_1} \Rightarrow V_2 = V_1 \frac{T_2}{T_2}$$

$V_2 = 89.002'661... \cong 89.03m^3$ (3)

$V_1 = 87.5m^3$; $V_2 - V_1 \cong 1.503m^3$

$\cong \underline{1'502.662 \text{ Liter}}$ (1)

2. $1kg\ CO_2$ (44g/mol);
$h = 11'034m$; $p_0 = 1atm = 101325\ Pa$
$T = 3°C$; $\rho = 1'050\ kg/m^3$

$p = p_0 + \rho g h = 101'325 + \overbrace{1050 \cdot 9.81 \cdot 11'034}^{113'655'717}$

$= \underline{113'757'042\ Pa}$ (1)

$1kg\ CO_2 \cong \frac{1000}{44} mol \cong 22.72 mol$

$pV = nRT \Rightarrow V = \frac{nRT}{p} = \cancel{0.455'373...}$

$\cong \cancel{0.455 \text{ Liter}}$

$= 0.458'695'...$

$\cong \underline{0.459 \text{ Liter}}$

3. $V = 3500\,m^3$, $m = 800\,kg$

$T_1 = 12°C = 285.15\,K$; T_2 = Temp. im Ballon

ρ_1 = Dichte aussen = $1.022\,kg/m^3$

$$\frac{\rho_2}{\rho_1} = \frac{\frac{pM}{RT_2}}{\frac{pM}{RT_1}} = \frac{T_1}{T_2} \Rightarrow \rho_2 = \rho_1 \frac{T_1}{T_2} \qquad (1)$$

$$F_{Auftrieb} = F_{Abtrieb}$$

$$\rho_1 V g = \rho_2 V g + m g \quad / : g \qquad (1)$$

$$\rho_1 V = \rho_2 V + m \quad ; \rho_2 = \rho_1 \frac{T_1}{T_2}$$

$$\rho_1 V = \rho_1 \frac{T_1}{T_2} V + m \quad / -m$$

$$\rho_1 V - m = \rho_1 \frac{T_1}{T_2} V \quad / \cdot T_2$$

$$T_2 (\rho_1 V - m) = \rho_1 T_1 V$$

$$T_2 = \frac{\rho_1 T_1 V}{\rho_1 V - m} \cong 367.3\,K$$

$$\underline{T_2 = 94.146°C \cong 94.1°C}$$

$(\rho_2 = 0.793\,kg/m^3)$

(4) N_2: 28 g/mol = M

$V = 0.15\,m^3$, $T_1 = 45°C = 318.15\,K$

$p_1 = 314\,bar = 31'400'000\,Pa$

a) $p_1 V = nRT_1 \Rightarrow n = \frac{pV}{RT} = 1780.651'621$

$n \cong \underline{1'780.652\,mol}$

$n \cdot M = 49.858'245\ldots$

$\cong \underline{\underline{49.858\,Kg}}$

b) $n' = 0.8n$ ($\frac{1}{5}$ des Gases entweicht)

$T_2 = 12°C = 285.15\,K$

$p_2 V = n'RT_2 \Rightarrow p_2 = \frac{n'RT_2}{V}$

$p_2 = 22'514'436.6\,Pa = \sout{28'143'045.7\,Pa}$

$\underline{p_2 \cong 225.144\,bar} \quad \underline{\underline{\cong \sout{281.43\,bar}}}$

$2.251 \cdot 10^7\,Pa$

oder: $\frac{n'}{n} = 0.8$

$\frac{p_2 V}{p_1 V} = \frac{n'RT_2}{nRT_1} \Rightarrow p_2 = 0.8 \cdot p_1 \cdot \frac{T_2}{T_1}$

$p_2 = 225.144\,bar$

5. $V = 25\,l = 0.025\,m^3$

$T = -60°C = 213.15\,K$

$p = 0.1\,Pa$

a) $pV = nRT \Rightarrow n = \frac{pV}{RT}$ (1) $= 1.410'652 \cdot 10^{-6}\,mol$ (1)

$n \cdot N_A = 1.410'652 \cdot 10^{-6} \cdot 6.02 \cdot 10^{23}$

$= 8.49 \cdot 10^{17}$ Moleküle in $0.025\,m^3$ (1)

Volumen pro Molekül $= \frac{0.025\,m^3}{8.49 \cdot 10^{17}}$ (1)

$= 2.944 \cdot 10^{-20}\,m^3$/Molekül (1)

$\sqrt[3]{\ }$ ⟶ Seitenlänge eines Würfels mit obigem Volumen:

$d = 308.77\,nm$ (Nanometer) (1)

$(= 3.09 \cdot 10^{-7}\,m)$

b) $\rho_1 = 1.293\,kg/m^3$; $p_1 = 101325\,Pa$, $T_1 = 273.15\,K$

$\rho_2 = ?$, $p_2 = 0.1\,Pa$, $T_2 = 213.15\,K$

$\frac{\rho_2}{\rho_1} = \frac{\frac{p_2 M}{R T_2}}{\frac{p_1 M}{R T_1}} = \frac{p_2 T_1}{p_1 T_2} \Rightarrow \rho_2 = \rho_1 \frac{p_2 T_1}{p_1 T_2}$

$= 1.635\,mg/m^3$

$\rho_2 = 1.293 \cdot \frac{0.1\,Pa \cdot 273.15}{101325\,Pa \cdot 213.15}$