Numerical Solution of Barometric Formula

Fluxion Example Description

The barometric formula results from assuming a constant temperature in the atmosphere (justified?) according to the following differential equation:

$$\boxed{\frac{dp}{dh} = -\rho(h)\, g}$$

With the relation for density and pressure:

$$pV = NkT \qquad \text{oder} \qquad pV = nRT$$

$$p = \underbrace{\frac{N \cdot m_{N_2}}{V \cdot m_{N_2}}}_{\rho} kT \qquad\qquad p = \underbrace{\frac{n N_A \cdot m_{N_2}}{V \cdot N_A \cdot m_{N_2}}}_{\rho} RT$$

$$p = \rho \cdot \frac{kT}{m_{N_2}} \qquad\qquad \vdots$$

$$\rho = \frac{p \cdot m_{N_2}}{kT} \quad \xrightarrow{k = \frac{R}{N_A}} \quad \rho = \frac{p \cdot N_A \cdot m_{N_2}}{RT}$$

follows

$$p' = \frac{dp}{dh} = -\frac{p\, m_{N_2} g}{kT} \quad \text{od.} \quad \frac{dp}{dh} = -\frac{p N_A m_{N_2} g}{RT}$$

Annahme: $T = \text{const.}$ (g auch)

$$\boxed{p' = -p \cdot \text{konst}}$$

$$m_{N_2} = 28 \cdot u = 28 \cdot 1{,}66 \cdot 10^{-27}\,\text{kg}$$

$$g = 9{,}81\,\frac{\text{m}}{\text{s}^2}$$

$$k = 1{,}38 \cdot 10^{-23}\,\frac{\text{J}}{\text{K}}$$

$$T = 293\,\text{K}$$

$$\Rightarrow \text{konst.} := \frac{m_{N_2} \cdot g}{kT} = 1{,}1(3) \cdot 10^{-4}\,\frac{1}{\text{m}}$$

In addition to the simulation, a comparison function is displayed. Use the slider to make sure that the pressure response of the exponential function follows the parameter b calculated by us and the initial pressure of 101.3 kPa.